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A NEW CENTRAL STATION

MERCHANTS' HEAT AND LIGHT CO.

BY W. J. MAXWELL

SOME FEW YEARS AGO a few enterprising merchants of Indianapolis desiring to eliminate their own individual plants formed a company amongst themselves and built a steam heating and lighting plant sufficiently large to care for their own wants. They were induced by others to sell their service. Such was the starting of the present company. As additional service was taken on, the enlarging of the station began and kept up until further extensions became impracticable in the old station.

It was never intended in the formation of the company to do a general commercial business. The location of the old station lacked facilities for economy of operation; water was purchased at metered rates; coal was hauled to the station in wagons; ash was disposed of by contract. Greater facilities and economies were necessary so J. G. White & Co., Inc., were retained to report, and they recommended a new central station, with new substation equipment.

The new central station of the Merchants' Heat and Light Co. is located on West Washington Ave., and extends through to Market St., its location being within a few blocks of the business section of the city. Railroad and water facilities are good. About the time of the starting of the first unit, it was apparent that owing to the large increase in the business an

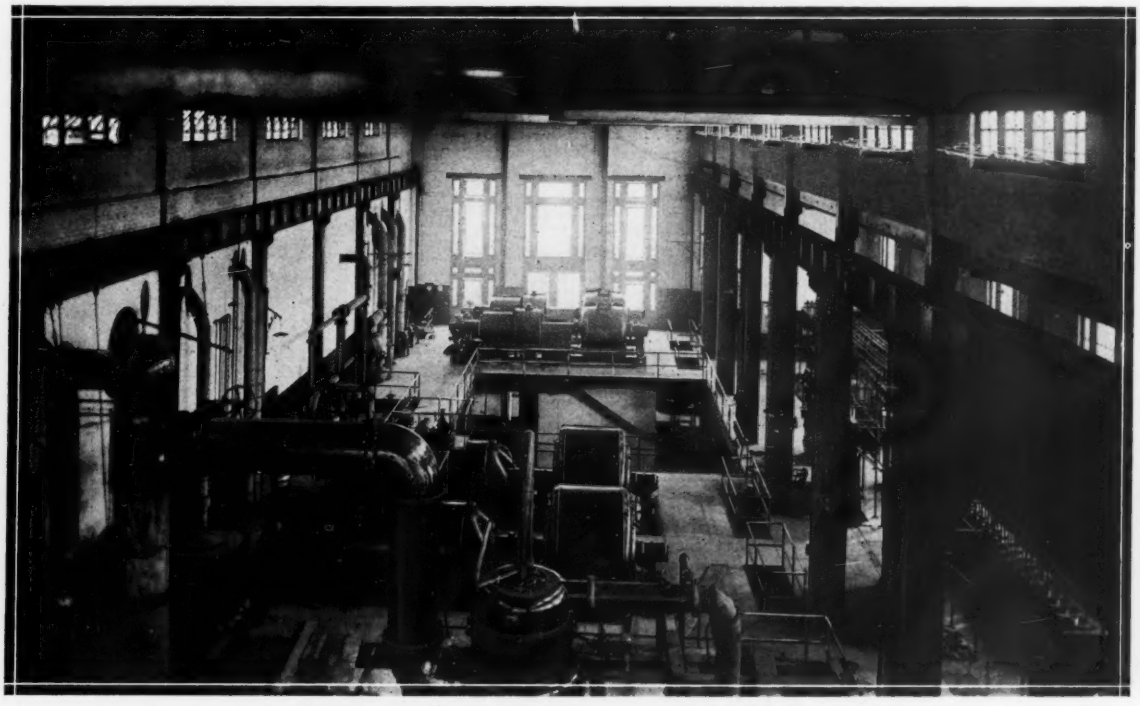


FIG. 8. MAIN TURBINE ROOM

addition to the station would have to be made, and to meet this service 6 additional boilers and an engine were added.

Building

THE building is 165 by 150 ft., with entrance on Washington Ave. The structure is of concrete, steel frame and red brick with Colitic trimmings. The floors and roof are of concrete. Interior columns extend below basement floors, outside columns to the ground line. The concrete foundations are on a sandy subsoil so that no waterproofing was required. The

FIG. 1. EXTERIOR VIEW OF THE STATION

roof is supported by steel trusses resting on steel columns. The interior walls and ceilings were given a coat of white water paint. The windows are opened and closed from the floors by a patented window operating device.

In the boiler room are 2 rows of wire glass skylights, one above each row of boilers, extending the full length of the room and having at each cross aisle between batteries of boilers a ventilator, an arrangement which gives good light and ventilation above the boiler settings. In the center of the boiler room above the firing aisle is the coal bunker. It is of the suspension type supported by I beams and steel columns, with bunker extending the full length of the boiler room and is made of reinforced concrete, the bottom of which is V-shaped. In the basement are rest rooms, and lavatories with lockers, basins, and shower baths for the convenience of the employes.

Water Supply

WATER supply for the station is obtained from a nearby canal, this water being well suited for boiler feed water and condensing purposes. Two 36-in. mains lead from the canal to the station, one being the intake, the other the overflow, and on the intake is a Venturi meter which measures all the water coming into the station from the canal. An additional auxiliary city water line with meters is also brought into the station and used as an emergency line.

Coal Handling

ON the east side of the building is the coal storage yard, the capacity of which is about 4000 tons. It is surrounded on 3 sides by a concrete retaining wall, on the fourth side by the tracks of the locomotive crane. Between the storage yard and the building are 2 spur tracks with capacity of 10 cars, these tracks passing over a large steel hopper, so that dump cars are run over the hopper and dumped. All other cars are craned out either to the storage yard or hopper by an electric locomotive crane, built by the Browning Engineering Co. of Cleveland, Ohio. This crane is also used for the switching of cars in and about the yards.

The capacity of the crane is about 60 tons an hour, the bucket of the clam shell type lifting about 3000 lb. to a grab. Direct current at 120 volts, taken from a third rail is used for the operation of the crane.

Coal is carried from the coal hopper to a single roll Mead-Morrison crusher by a Link Belt carrier or pusher, and passing through the crusher drops into a hopper under which passes a Link Belt bucket elevator which takes the coal to the top of the building. Here it is dropped into a cross belt and carried to a belt conveyor running the entire length of the boiler room, thus by a tripper distributing the coal to any desired point in the bunker.

The crusher, pusher, elevator and conveyors are operated by 3-phase induction motors at 250 volts.

Ash Handling

THE basement, in which all the ash is handled, is the full size of the boiler room.

Beneath the boilers are spacious semi-V-shaped ash hoppers with undercut gates, the ash being cooled down by a sprinkling system; to the rear of the ash hoppers are cast-iron soot hoppers. Ash hoppers discharge into 2 Koppel yard cars in the basement, tracks for which run the length of the basement beneath the 2 rows of boilers, conveniently located turntables permitting the running of cars to the coal elevator, which elevates the ash to a 60-yard concrete ash bunker. This bunker has an out spout to the cars on the coal track,

FIG. 2. COAL YARD FACILITIES

so that it is possible to refill a coal car with ash immediately. Responsibility for the ash ceases here as the railroad company will accept them for fill.

Boilers and Fittings

THE MAIN entrance to the station is through the boiler room facing Washington Ave. side. The installation at the present time includes 16 Sterling wa-

ter-tube boilers, 12 of 500 hp. capacity and 4 of 612 hp. each, allowing 10 sq. ft. of heating surface to the horsepower. The ratio of grates to heating surface is 1 to 50. The boilers operate under a working pressure of 175 lb. These boilers are suspended in the usual way for this class of boilers, using the bunker columns for support.

Each boiler is equipped with water columns, 2 4.5-in. Consolidated pop safety valves, 1 G. M. Davis Co. automatic cutout valve and 1 extra heavy gate valve. The blowoff lines are equipped with 2 valves connected in series, 1 being a Crane extra heavy gate and the other an Atwood angle valve. All the blowoff lines are of extra heavy steel pipe and lead to a steel blowdown tank situated in the basement, and to the roof through a 6-in. pipe and to the sewer by an 8-in. waste pipe.

Boiler Settings

IN the brick work on the boilers the usual practice was deviated from. Past experience has shown the weakness of this setting under hard service, a common failing being with the main and coking arches, side and bridge walls which would burn out or fail after 1 to 2 months' service. To overcome this trouble the fire brick linings have been increased in thickness, the bridge walls laid up entirely of fire brick, and main arches and a portion of the coking arches laid up with 13-in. blocks, made to order. These blocks form an arch with an 11-ft. span, and a spring of 22-in., with skew backs of blocks conforming in size to the arch blocks.

Arches and side walls are plastered with a thin grouting of fire clay in which is mixed a liberal amount of salt. A hard glaze formed after firing, and after 5 months of hard service these furnaces show no visible sign of failing. The red brickwork was laid up in lime mortar with a small amount of cement, the tops covered with 2-in. of plastic magnesia and 2 courses of red brick, finished with a ½-in. covering of cement mortar.

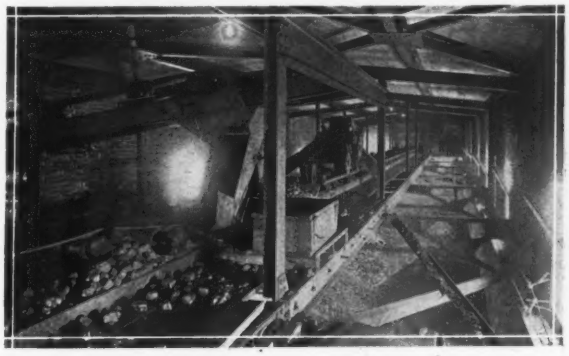


FIG. 4. LONG BELT CONVEYOR AND COAL BUNKER

Boilers are set in batteries of 2 facing a common firing aisle extending the full length of the boiler room. In the rear of each row of boilers is an 8-ft. aisle, which with 6-ft. cross aisle between batteries give free access to all parts of boilers and settings. Smoke flues 8 by 12 ft., over rear aisles extend the full length of the boilers. The bottoms of these flues are of reinforced concrete supported by 10-in. I beams, the tops of hollow tile, laid in concrete with reinforcing rods. The sides are

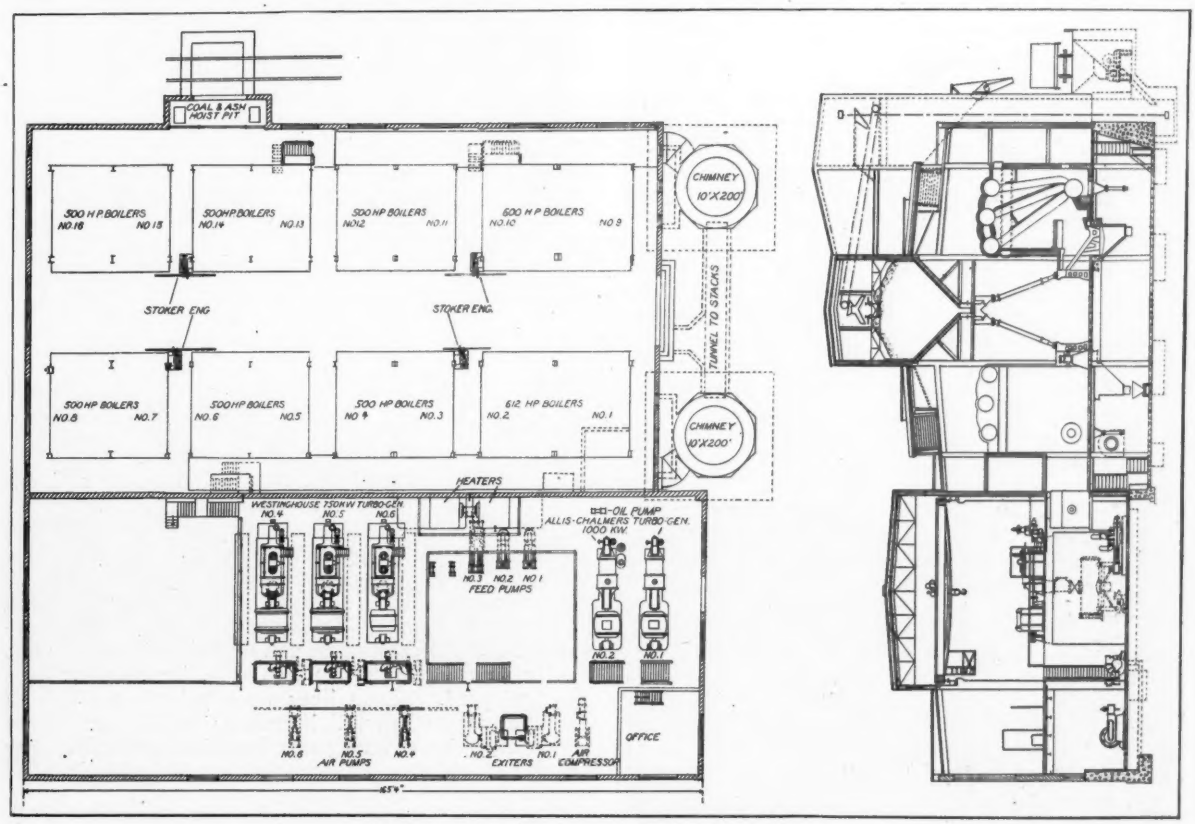


FIG. 3. PLAN AND SECTION THROUGH STATION

of brick. These smoke flues lead to 2 large radial brick stacks at the front of the station, connections to stacks being made by steel breeching. The stacks have a height of 200 ft., and a diameter of 10 ft., producing a draft of 1.2 in. at the base.

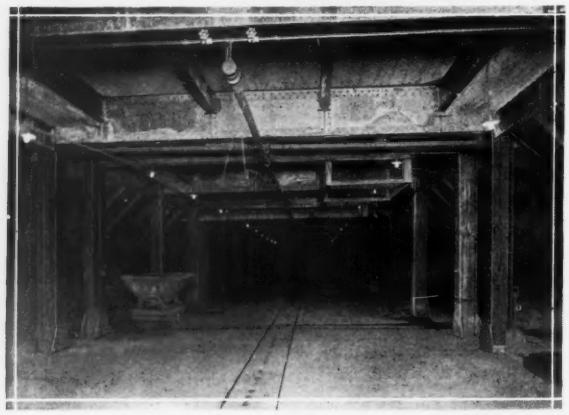


FIG. 5. BASEMENT ASH HANDLING SYSTEM

Each boiler has its own individual damper hand operated from floor, but at the point of entrance of smoke flue to stack is a stack damper automatically operated by a damper regulator.

Stokers

BOILERS are equipped with Roney stokers of the latest type, single stokers being in use on the 12 500-hp. boilers and double stokers on the 612-hp. Each stoker engine operates 4 stokers, but in case of stoker engine trouble, convenient couplings enable continuous operation by adjoining engines.

Piping

HIGH-PRESSURE piping of the station includes steam, water and blowoff piping, and was designed for a working pressure of 250 lb.

On the steam lines all steel piping was used. Piping above 6-in. is full weight; smaller than 6-in. is extra heavy. The boiler feed lines from discharge of boiler feed pumps to 2½-in. branch lines to boilers are extra heavy cast-iron flanged pipe; the boiler feed

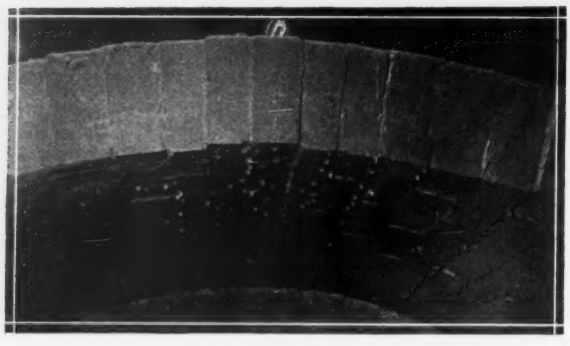


FIG. 6. MAIN FIREBOX ARCH AFTER FIVE MONTHS' USE

branches from header to boilers are brass pipe, of extra heavy iron pipe size and thickness. The blowoff lines are of extra heavy steel pipe.

All fittings are of extra heavy cast iron suitable for 250-lb. working pressure. Fittings 2½ in. or above are flanged, smaller than 2½-in. screwed. All joints 6-in. and larger are of the Vanstone type, with corrugated copper gaskets; smaller than 6-in. screwed. The header is inside the boiler room and next to the division wall, and connecting into this header on the sides are the 16 boiler steam lines with long sweep bends.

From the top of the header on which are placed automatic cutout valves, steam lines passing through the engine room wall drop down by long easy bends connecting to the turbines and engine. From near the ends and middle section of the steam header branches a steam loop, which encircles the engine room basement, to supply steam to the 2 exciter sets, boiler feed and house pumps, air compressor, circulating pump and wet and dry vacuum pumps.

Header and basement loop are so divided up with cutoff valves that any section of line may be cut out and not materially affect the continuous operation of the station. The steam branch lines to turbines and engine as well as the auxiliary steam loop are equipped with Cochrane separators. The main steam header, auxiliary loop and all steam separators are drained by

FIG. 7. GOTHIC ARCHED HALL OF STOKERS

Anderson's high-pressure steam traps, which return all condensation to the heaters.

Pipe Covering

BOILER heads, heaters, steam, hot water and exhaust lines are covered with sectional magnesia block and plastic insulating covering, the heaters and boiler heads being covered with sectional block wired on and finished with a plastic cement finish. The high-pressure steam lines have double insulating covering, water and exhaust lines single covering. All insulated lines are canvassed, sewed, painted and banded.

In painting the station, color designation for lines was adopted. Steam lines were painted a shade of orange; water lines, light green; and exhaust lines red. The pipe covering was furnished and work done by Kessby-Matteson Co., and Johns-Manville Co., and the waterproof and abrasion-proof covering of engine exhaust and between cylinders was done by the Richards-Wilson Co.

Heaters

TWO Cochrane feed-water heaters of 5000 hp. capacity each are installed in the division wall in the basement, being accessible to both boiler and engine room. All auxiliaries exhaust into these heaters, provision having been made by which additional exhaust

from the heating mains may be turned to the heaters, when the auxiliary exhaust is insufficient to maintain the feed-water temperature. These heaters maintain a temperature of about 200 deg. F.

Boiler Feed

BOILER feed pumps are located in the turbine room basement, setting about 8 ft. below the feed-water heaters. There are 3 boiler feed-water pumps 16 by 10 by 18 in., outside packed, double acting duplex plunger type, fitted with bronze valves and seats; one of these is a Worthington, one a Warren and the 3rd from Dean Bros. of Indianapolis. In addition to and alongside of boiler feed are 3 house pumps, 2 of which supply the heaters and cooling coils of the turbines, while the third, a Laidlaw-Dunn-Gordon, is for general use about the station. All pumps are equipped with governors, water relief valves, automatic cylinder drain cocks, and Richardson automatic lubricators.

Leading from the boiler feed pumps passing through boiler room basement are 2 6-in. cast-iron discharge feed-water lines. These lines rising through the boiler room floor connect into a 4-in. loop encircling the fronts of the boilers, from which loop brass feed-water lines connect to each boiler. These water lines as well as all steam and exhaust lines are hung from I beams by means of clamps and hangers with a system of bracing to prevent vibration.

Generating Outfit

PRIME movers are located on 2 levels. The engine at the basement floor level and the turbo-alternators about 19 ft. higher on concrete piers. The granolithic floor around machines is reinforced concrete beams and girders. Four turbo-alternators are installed, all of the horizontal multiple expansion parallel, full annular flow "reaction" or Parsons type. The turbines are direct connected to the revolving fields of the generators by a flexible coupling, the rotors of the turbines and generators each being carried by 2 bearings allowing each rotor to be handled separately. This allows quick and ready inspection of the turbine rotor.

End trust is taken care of by balance pistons small enough to avoid distortion due to pressure and difference of temperature. Where the rotor shaft passes out of the turbine cylinder, glands sealed by water are used.

The generators are of the enclosed type with forced ventilation, air being taken from the outside of the building through sheet-iron air ducts. Two of these machines are Allis-Chalmers noncondensing 1000 kw., and are in service during the heating season from Sept. 25 to May 25. The steam consumption varies from 38 lb. per kw. hr. to 52 lb., according to the back pressure carried in the heating system. The other 2 machines are Westinghouse, condensing of 850 kv.a. The turbines are equipped with speed control governors, electrically operated from the switchboard.

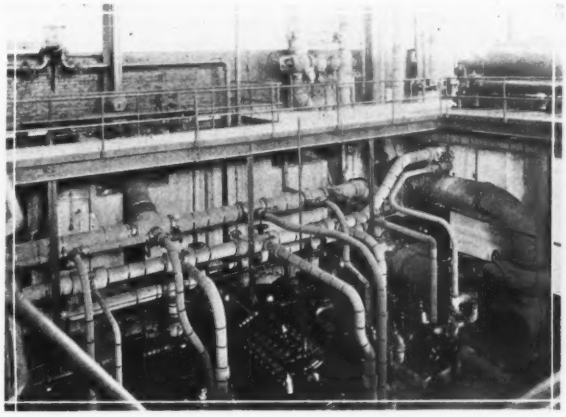


FIG. 9. PUMP PIPING AND HEATING MAIN

Condenser Equipment

BENEATH the condensing turbines and between the concrete piers are Worthington surface condensers, and directly under the condensers are 2-stage Worthington centrifugal hot-well pumps direct coupled to Terry steam turbines running at 1500 r. p. m.; these pumps deliver the condensation to the heaters. Condensing water is obtained from the forebay of the canal, entering the circulating pumps under a 9-ft. head. After circulating through the condensers, it is returned to the canal by volute pumps driven by a high-speed Harrisburg engine direct coupled.

The dry-vacuum pumps are Worthington straight rotative pumps 6 by 12 by 12 in., set to the rear of the circulating pumps, and giving a vacuum of 28 in. by mercury column.

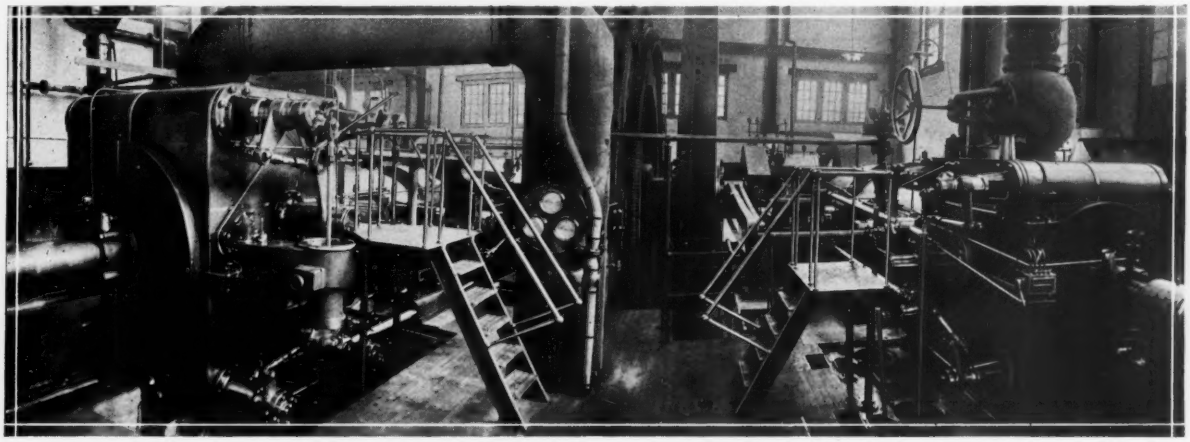


FIG. 13. CYLINDER END OF COMPOUND ENGINE

Engine

THE recently installed Allis-Chalmers engine is direct connected to an Allis-Chalmers alternator. This engine was selected as the most elastic and economical unit to meet the peculiar load conditions. The machine selected would have to operate condensing or noncondensing, with a back pressure as high as 12 lb. or with a vacuum of 24 in. Turbine builders were not ready to meet these conditions and the engine was decided upon.

It is a cross-compound, horizontal, heavy-duty Corliss with long range cutoff, one governor controlling cutoff for both high and low sides. In addition is a safety governor stop to prevent the engine running away, should the governor belt break or any derangement of valve gear take place. Some of the dimen-

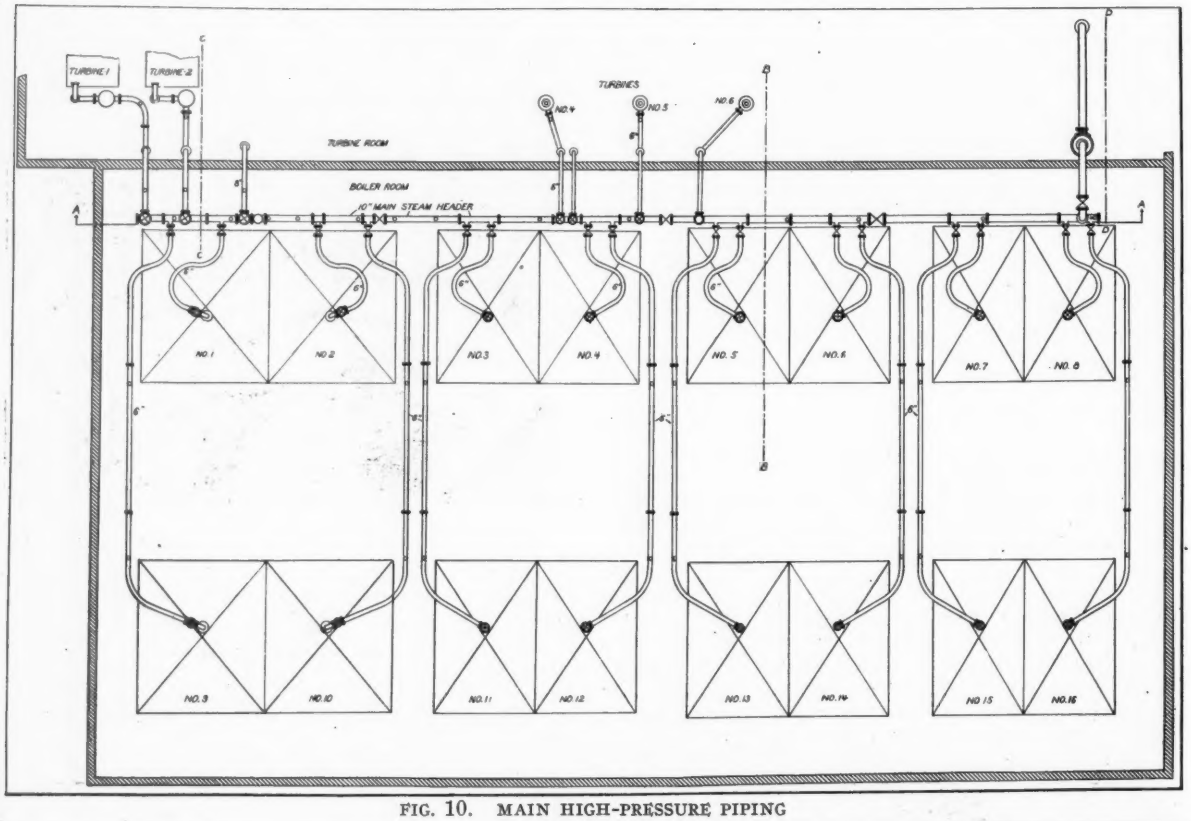


FIG. 10. MAIN HIGH-PRESSURE PIPING

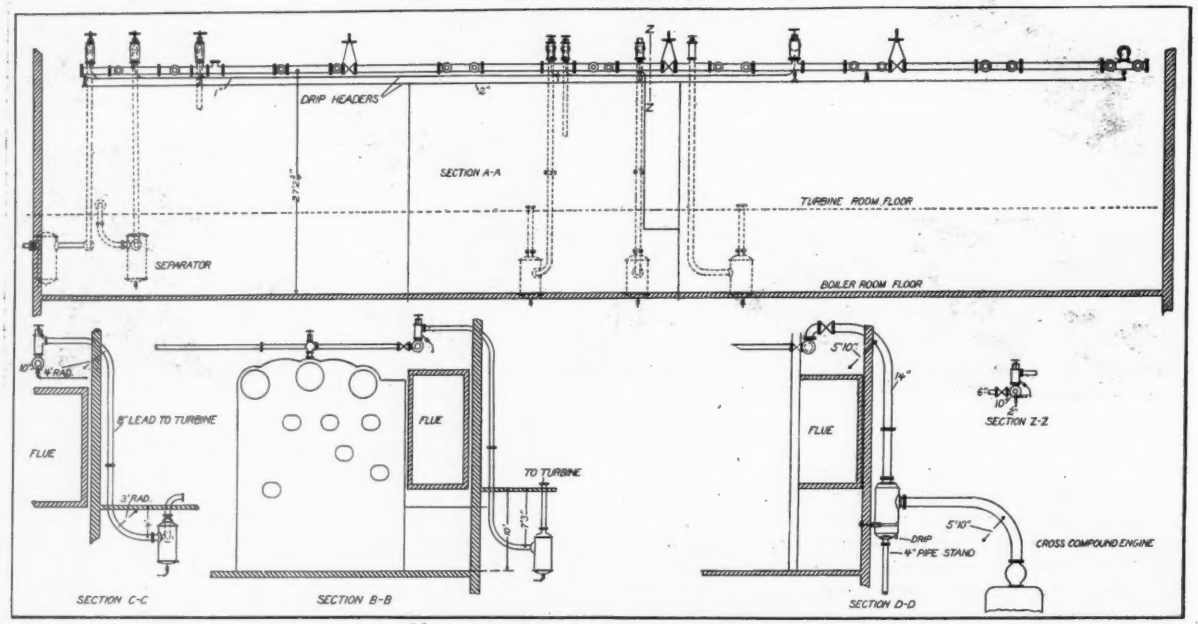


FIG. 10A. SECTIONS OF HIGH-PRESSURE PIPING

sions and weights are as follows: Cylinders, 44 and 78 by 54 in.; main journals, 30 by 56 in.; bottom bearing with a water jacket; valve gear operated by 2 eccentrics on high and low side; a 28-ft. cast-steel flywheel made in 5 sections with inserted links in the rim, approximate weight of which is 114 tons; shaft at wheel 34 in. diam., weight 57 tons; rotor of generator weighs 53 tons; hollow piston rods for high side 11 in., low side 16 in.; tail rods on high and low sides; Cook's metallic packing on rods and valve stems; exhaust valve gearing on low side so constructed that valves can be set quickly to suit either the condensing or back pressure conditions without moving the eccentric.

Most economical point of operation of the unit is as follows: Noncondensing 3400 kw., condensing approximately 3000 kw.; the maximum capacity is with 12 lb. back pressure, 5500 hp. Steam consumption is approximately 21.5 lb. condensing at the most economical load; noncondensing, 33 lb. at most economical load.

Condensing Equipment

CONDENSING equipment of the engine consists of a Worthington countercurrent induction, jet condenser, setting above a 14-in. volute wet vacuum pump to which is coupled a 90 hp. Kerr steam turbine running

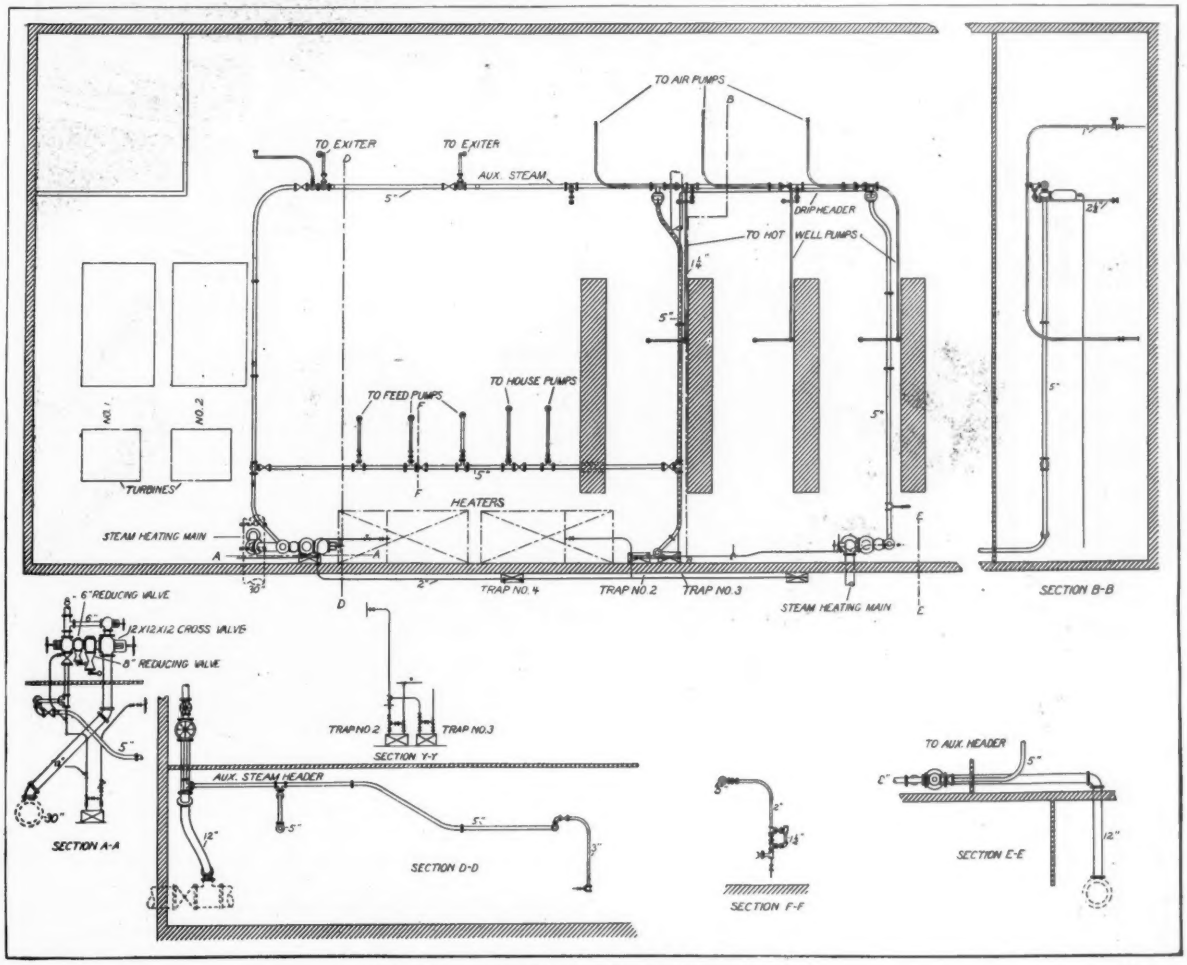


FIG. 11. AUXILIARY HIGH-PRESSURE PIPING

Between the 2 cylinders is located a steel receiver in a concrete receiver pit drained of all condensation by a Cranetilt trap. The lever on the trap is electrically connected to 2 light circuits, one showing red when the trap is discharging, the other green when the trap lever is down and trap not discharging.

Steam line to the high-pressure side is 14-in. pipe; from receiver to low-pressure side, 26 in.; exhaust 30 in. The engine runs at a speed of 90 r. p. m., and parallel with the steam turbines. Piston speed is 810 ft., run speed of wheel nearly 8000 ft. per minute. The Richardson force feed continuous oiling system is used on the engine, but an additional gravity system ties into the former, allowing either to be used separately or in conjunction.

at 1450 r. p. m. This pump returns the water to the canal except such portion as is used for makeup water in heaters. A rotative dry-vacuum pump 10 by 18 by 18 in. connects to the condenser at the top through an 8-in. line.

Exciters

INDEPENDENT steam-driven exciters, located on the basement floor level beneath the electrical gallery furnish exciting current for the alternators, house and locomotive crane. The exciter sets consist of 2 Chandler and Taylor high-speed engines of the enclosed, self-oiling type, direct connected to Allis-Chalmers direct-current generators of 100 kw. capacity at 120 volts. At the side of the exciter sets is a

Laidlaw-Dunn-Gordon air compressor 12 by 12 by 12 in., which supplies air to regulate the steam heating system.

Switchboard

ON the turbine floor level to the west of turbines is the electrical gallery. The board is for remote control, one set of oil switches for 2 sets of busbars and disconnecting switches. The board is composed of 3 sections. One direct current, one alternating current and the feeder panels. The switchboard is made of oil finished black slate, supported by steel frame work, so constructed that additional panels can be added.

The panels are 2 in. thick and made in 2 sections. The main slab being 62 in. high, sub-base 28 in., width 20 in. Oil switches are mounted in brick compartments with solenoid operated switches mounted below the switch and within the compartment. Indicating lamps and alarm bell switches are supplied for all oil switches. All instruments are of the dead-beat type with dull black finish, and with shunt current and potential transformers. The switchboard controls 2 100-kw., 125-volt, exciters; 2 850-kw., 3-phase, 60-cycle, 2300-volt generators; 2 1000-kv. a. and one 3350; 7 800-kw., 2300-volt alternating current circuits, 5 of which are underground and 2 overhead.

On the exciter panels are 2 175-volt, direct current meters and 2 1000-ampere ammeters, a 4-point potential receptacle and an 800-ampere 250 volt lever switch and rheostat operating mechanism. On each generator panel is a polyphase indicating wattmeter, power-factor indicator, alternating current ammeter, rheostat operating mechanism, 8-point potential receptacle, field switch with discharge resistance clip, governor control switch, 1 300-ampere 2300-volt non-automatic solenoid operated oil switch and 1 1500-watt polyphase integrating wattmeter.

On a swinging panel connected to the alternating current board is a 1-phase syncroscope, syncronizing lamp and 3-voltmeters. On the circuit feeder panels are 300-ampere alternating current ammeters, automatic solenoid-operated oil switches for mounting in cells and definite time limit relays. On the top of panel of the alternating current board are mounted 2 frequency meters. The switchboard and instruments were furnished complete by the Westinghouse Electric and Manufacturing Co.

In the rear of the board are station transformers from which lights and power for operating motors are taken.

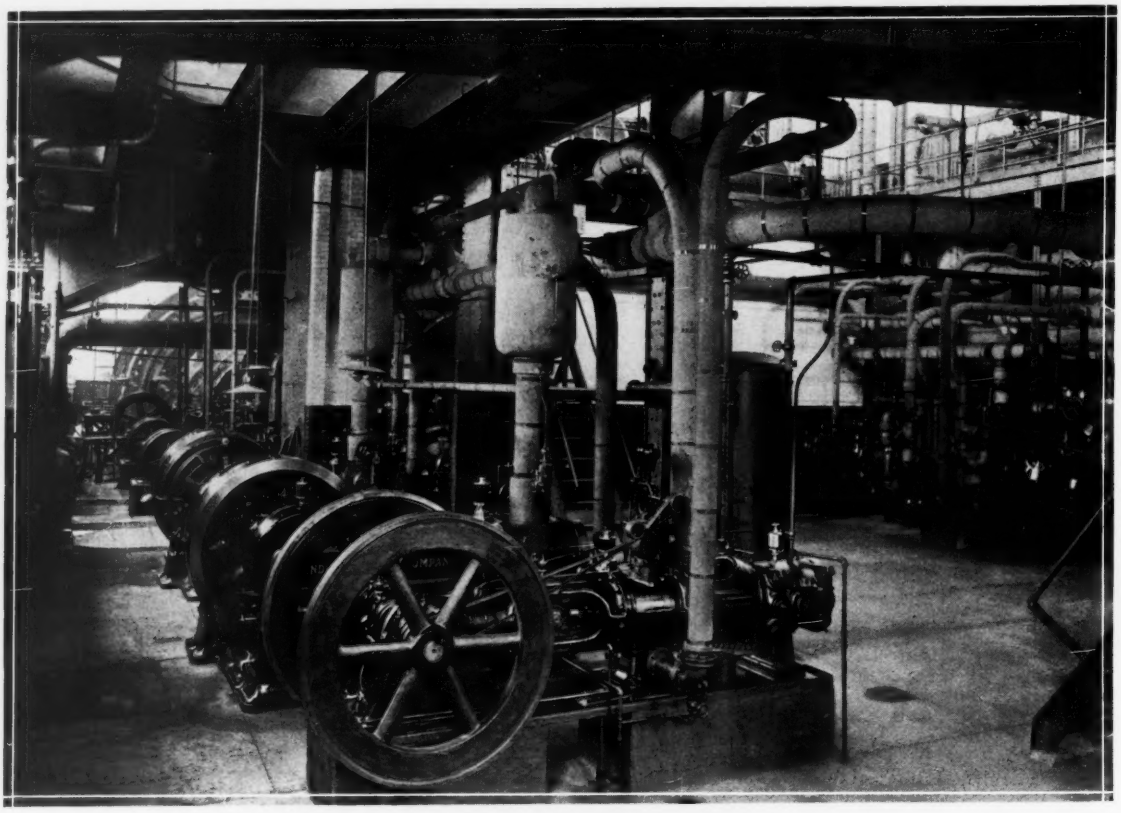


FIG. 12. PUMPS IN ENGINE ROOM BASEMENT

Station Load and Operations

ON the station is a power, lighting and steam heating load. Current is sold on a basis of a thousand kilowatt-hours as shown by meters installed and maintained by the company.

The power load is constant during the day. The lighting load comes on at about the time the power load is going off, the peak load on the station being between 4:30 and 5:30 p. m. During this load it is often necessary to put on an additional unit. A portion of the lighting load goes off at 11 p. m., and from that time on until 7 a. m., the load is constant. The average load is from 40,000 to 50,000 kw. for the 24 hours.

Underground circuits lead to 2 downtown substations of 2000 kw. capacity each, in one of which sub-

stations are 2 motor generator sets and storage battery, sufficiently large to care for the direct current lighting load for one hour.

The overhead circuits supply current to the outlying districts. Current is transmitted over these circuits at 2300 volts, stepped down to the desired voltage at the premises of the consumer.

Steam Heating

STEAM heating load on the station is about 900,000 sq. ft. of radiation, exhaust steam being used for the heating; but at times of light load or extreme cold weather live steam is used in connection with the exhaust. When live steam is so used the pressure is lowered by passing it through 2 reducing valves installed at the heating main, which reduce the pressure from 175 lb. to the pressure of the heating main.

Leading from the station to the central portion of the city is a 30-in. riveted steel pipe with slip, expansion joints at intervals to take care of the expansion, and traps to care for the condensation along the line. This line is laid in a concrete tunnel with manholes at short intervals for inspection and repairs. The consumers provide and maintain the building equipment, suitable steam traps of sufficient capacity to properly handle the condensation from the heating system of the buildings, without loss of steam; also provide and install as near as practicable to the company's main service valve a Powers regulating valve for controlling the temperature of the building. These valves are connected up with air and a thermostat set to maintain a temperature of 70 deg. within the building.

For operating these regulating valves air at 15 lb. pressure is maintained on the air line by the company.

The pressure schedule adopted and which has proved sufficient for the service is as follows:

Outside Temp. deg. F.	Pressure, lb. 4 a. m. to 8 p. m.	Pressure, lb. 8 p. m. to 4 a. m.
65	3	3
60	4	3
55	4½	4
50	5	4
45	5½	5
40	6	5
35	6½	6
30	7	6
25	7½	7
20	8	7
15	8½	8
10	9	8
5	10	9
0	11	10

This pressure is maintained at the station and has proven sufficiently high to give good service.

Heating is charged for on a flat rate or a meter basis. In the latter case the condensation is metered back. Recording temperature and back pressure gages show the temperature and back pressure carried during the 24 hours.

For check as well as information on the heating, tests are occasionally run for a period of 4 to 6 weeks' duration. A steam flow meter is inserted in the main and hourly readings taken; at the same time a calorimeter test of the steam and temperature and pressure as recorded by a mercury column are taken. During this time the temperature as recorded by the weather bureau are used.

The cost of operation is placed to 2 accounts, one being the electrical and the other the steam heating. The electrical cost per kilowatt hour at the board during the summer season is maintained during the heating season, and the additional cost during this time is charged to the heating.

This station was designed and erected by the J. G. White & Co., Inc., New York City, L. S. Shaw, construction superintendent, and E. Darrow, general manager for The Merchants Heat and Light Co.

BABBITTING LARGE ENGINE BEARING

By M. J. Conlon

WE will assume that an engine is in operation and through carelessness of the engineer or oiler the main bearing is burned out, causing a shut-down. The bearing is in such bad shape it must be babbitted, it is in 4 parts and each part is called the quarter box. In order to get the box out, the shaft and flywheel must be raised, and in order to do this the connecting rod and eccentric rods must be taken off. The caps are taken off the main and outboard bearings and a spirit level is tried on the shaft to see how much it is down, that found a note is made of the amount.

Now the top quarter, the sides, the take-up wedge, and also the top of the outboard bearing are removed. All is then ready for raising the shaft and flywheel. It is necessary to have some good blocking because the load is heavy, also some good jacks, preferably hydraulic jacks, and chain falls. The shaft and flywheel are raised high enough so that the bottom quarter can be removed, the shaft is securely blocked and the strain taken off the jacks, or whatever apparatus is used to raise them, but these are left in position. Take the 4 quarters out, place each of them in an inclined position, heat a pot of babbitt and pour it over them, melting out the old babbitt and saving it.

Now the quarters are all clear of the old babbitt and, as every man of experience knows, they must be clean and free froim oil when pouring the new babbitt. There is no way I know that will clean them of the oil as well as burning them in a fire.

It is necessary to get a form to lay into the quarter while the babbitt is being poured. The form must be of less diameter than the shaft, so as to allow for boring the boxes after they are poured. The form should be shimmed along the edges with cardboard strips so as to keep it away from the iron as much as necessary. Have the quarters as near the forge as you can for convenience in pouring the babbitt. The form is placed in position and held in place by clamps, the whole mould is stood on its end and pouring is done when the metal is hot enough to brown the end of a pine stick by passing it through the metal, each quarter is treated alike, and when all are poured lay each quarter down on a good bench and peen the babbitt with a good hammer and especially around the edges, making it firm before it is put in the lathe.

When the quarters are treated in this way they should be assembled and placed in position for boring; the take-up wedge is placed in with them and the outside callipers tried on them so that they will just go into the ways in the bed. When that is done and they are in a true circle they are ready for boring. They should be bored out 1/32 in. larger than the shaft; care must be taken that the quarters are plumb and held firmly together, as any variation may cause a lot of trouble later on. The boring is done and the depth of babbitt is the same in all the quarters,

the next thing to do is to cut oil grooves in each quarter the oil way should come only within ½ in. of the edge of the babbitt; they should be cut with a diamond point chisel and the edges of the grooves scraped so as to remove any burs that might be raised by the chisel. The edges of the babbitt should be trimmed and rubbed with a file so as to give the oil a chance to get around.

Now the quarters are ready to go back in place; the bottom is put in first and a straight edge is placed in it and one end resting on the bottom of the outboard bearing and a spirit level is tried to see if the boxes are in line; if not, the lower one must be shimmed. When in line the shaft and flywheel is lowered into place and the spirit level tried on the shaft to test the accuracy of the other trials; if right, all blocking is removed and the quarters are put in place and are given a good oiling.

The eccentric rods are put in the same as they were when taken down. The connecting rod is put on and oil cups are put in position. A great many engineers, and old ones at the business too, assume it is all right again and fit to run, but in some cases it is not. In babbitting the boxes as much babbitt got into the quarters as permissible to allow them to go into the ways in the bed plate, consequently there must be some change made in the clearance and the engine should be tried for clearance. The crank end is tested first and if the piston strikes the end of the cylinder it must be changed either by shimming the brasses in the connecting rod or screwing the piston rod out of the crosshead as much as will be necessary, if it is a screw end rod, a great many are connected by drawing keys and in them the brasses must be shimmed.

The clearance is divided up and the engine is now fit to run, but give the bearings a good oiling and take up lost motion carefully, but not too much until it has run some time, and I promise no more trouble except in extreme cases of carelessness.

A HOT PROCESS FOR FEED WATER PURIFICATION*

By Walter C. Elder

NECESSITY for purification of feed water in order to avoid the formation of hard boiler scale has been frequently proved and the desirability of some process of softening is evident from the fact that ⅛ in. of scale, as shown by tests of Prof. Smith, of the University of Illinois, adds 11 per cent to the fuel burned. This is corroborated by tests on the Illinois Central Railroad locomotives which showed that the capacity of the engines when recently cleaned was 11 per cent greater than after 3 months' use. Added to the extra coal is the extra cost of care, the extra danger of accident and the cost of boiler cleaning, firing of boilers which are out of service and the annual depreciation on extra boilers which must be installed to provide for the periodic cleaning.

Troubles Caused by Scale

TROUBLES due to water with the causes of the trouble and the cure which may be applied are shown in the chart, Fig. 1, which is taken from Christie's book on Boiler Waters. It is evident from this chart that by the use of heat, filtration and sodium carbonate, practically every trouble met with in ordinary boiler operation may be cured. Most of the sulphates are disposed of by adding carbonate of soda to the water, grain for grain, and the carbonates are thrown down upon heating the water, because the carbon dioxide is driven off by this heating, and when there is no carbon dioxide in solution in water it has not the power to hold carbonates in solution.

This throwing down of the carbonates occurs at any temperature over 200 deg. F. But while some sulphates may be thrown down by heating to somewhat over 300 deg., experiments have shown that at least 15 per cent of the sulphates will remain and these will be carried over into the boiler where they will not deposit until the solution becomes more than saturated.

The costs incurred by scale are the extra coal burned, 10 per cent; the extra investment of 1/5 to 1/7 in boilers due to the necessity for cleaning them; the extra cost of cleaning boilers, which amounts to from 10 cents to $1 per horsepower; the addition of extra tubes, which cost $5 each; the bringing up of boilers to pressure after cleaning, which costs 50 cents per 100 hp., and the depreciation charge, which is estimated to increase 15 per cent.

The Hot Process Method

FIGURE 2 shows the reactions obtained by the hot process. Here it will be seen that the carbonates are precipitated, the acids, which might otherwise cause corrosion, are neutralized. The other salts which are left in the solution are such as form a soft sludge in the boiler and may be readily blown out.

In the cold process treatment the carbonates are thrown down by the use of lime water and, as in all chemical reactions, the precipitation is much slower than when the water is heated. The cost of lime water treatment to precipitate 1 pound of carbonate of lime may be taken as follows:

	0.56 lb. of lime at ¼c per lb.	$0.0014
or	0.80 lb. caustic soda at 2c per lb.	.0160
or	3.15 lb. barium hydrate at 2½c per lb.	.0787
or	2.18 lb. sodium phosphate at 4c per lb.	.0872
or	11.92 lb. tannin extract, 27%, at 2¾c per lb.	.3278
or	2.28 lb. sugar at 5c per lb.	.1140

The cost of treating water to remove the sulphate of lime is given in the following table, showing the expense for removing 1 lb. of sulphate of lime from feed water.

	0.85 lb. of soda-ash at 1c per lb.	$0.0085
or	1.53 lb. barium chloride at 2c per lb.	.0306
or	1.60 lb. sodium phosphate at 4c per lb.	.0640
or	1.94 lb. sal-soda at 6.5c per lb.	.1261
or	8.76 lb. tannin extract, 27%, at 2¾c per lb.	.2409
or	1.68 lb. sugar at 5c per lb.	.0840

About 1 lb. of soda ash per 1000 gal. of water treated is required, using the hot process, for each 7 grains of sulphates per gallon. The question may arise as to what will become of the sodium sulphates which are formed by the chemical reaction. These go into the boiler in solution and may be removed periodically by blowing down. There will be no deposit of this sodium sulphate until the density reaches 44¼ parts of sulphate to 100 parts of water, which

*Abstract of an Address before the Chicago Association No. 1 of Sationary Engineers.

would mean that a water containing 15 grains of calcium sulphate per gallon could be boiled down to about 1/1650 part of its original volume before deposit would begin, a condition which would take care of 1000 hours' run of the boiler.

Besides treating the water with soda ash the hot process passes it slowly through a settling tank after being heated, to allow the carbonates to settle out, then filters it to take out the foreign matter and any floating matter which has not come out in the precipitation, then skims it to take off any light floating matter and finally sends it to the feed water pump soft, clear and hot.

Heating the Water

TO heat the water the exhaust steam from the engine is used or from drips from separators and pipe lines, the steam being first passed through an oil separator so that oil is removed. The fresh water and the returns from the heating system are carried into the heater so that only sufficient raw water need be used to make up for the waste in the plant. The amount of soda-ash solution fed into the softener is in proportion to the amount of raw water used and is mingled with the raw water as it enters the softener.

Trouble.	Cause.	Cure.
Incrustation	Sediment, Mud, Clay, Etc.	Filtration
	Readily Soluble Salts	Blowing-off
	Bicarbonate of Magnesia, Lime, Iron	Heating Feed and Precipitate
		Caustic soda
		Lime
		Magnesia
	Organic matter	See below
	Sulphate of Lime	Sodium Carbonate
		Barium chloride
Corrosion	Organic matter	Precip. with alum and filter
		Precip. with ferric chloride and filter
	Grease	Slaked lime and Filter
		Sodium Carbonate and Filter
	Chloride or Sulphate of Magnesium	Sodium Carbonate
	Sugars	
	Acid	Sodium Carbonate
	Dissolved Carbonic Acid and Oxygen	Slaked lime
		Caustic soda
		Heating
	Electrolytic action	Zinc plates
Priming	Sewage	Precipitate with alum or ferric chloride and filter
	Alkalies	Heating Feed and Precipitate*
	Carbonate of soda in large quantities	Barium chloride

* Probably an error; blowing off is the usual remedy.—Ed.

FIG. 1. TROUBLES DUE TO FEEDWATER AND METHODS OF CURE

Testing for Correct Working

TO determine whether the softening system is working properly there is a thermometer placed on the outlet which shows whether the temperature is coming above 200 deg. or not. If it is, the water has been heated enough to throw down the carbonates. To see whether the amount of soda-ash fed is correct or not, a testing device is provided on the outlet consisting of a sampling cup into which water may be drawn from the outlet pipe and above this a small glass containing phenanthroline. The correct amount is shown by a faint pink in the test glass after the addition of the re-agent. If too much soda solution is being fed, the water will turn red, while if too little is being fed, the water will remain clear.

The hot process thus provides a water softening system, a feed-water heater, an expansion tank and receiver for returns, a settling and precipitating tank, feed-water filter, oil separator and trap, a raw water regulator and a means of testing for the correct softening of the feed water.

AT A RECENT joint convention at Louisville, Ky., of the National Supply & Machinery Dealers' Association, the American Supply & Machinery Manufacturers' Association, and the Southern Supply & Machinery Dealers' Association, Mr. W. L. Rodgers, president of the Pittsburgh Gage & Supply Co., Pittsburgh, Pa., was elected president of the National Association. He was formerly vice-president of that body, and his election to the presidency is a well deserved honor.

Mr. Rodgers is one of the best posted supply men in the United States, having devoted practically his entire time for the past 18 yr. to the supply business and the manufacture of steam specialties. He has been unusually successful, as is evidenced by the growth of the company of which he is the head. The Pittsburg Gage & Supply Co. was started by Mr. Rodgers about 18 yr. ago in the corner of an old building in the down-town district of Pittsburgh. The stock was small and the capital still smaller, but energy unlimited. By carefuly management and hard work, the business constantly increased, and has developed into one of the largest and best equipped supply houses and manufacturing plants in the United States.

The same qualities which have made Mr. Rodgers so successful in developing the Pittsburgh Gage & Supply Co. will no doubt be just as effective in connection with his duties as president of the National Association, and his unanimous election to that office is an evidence of the high esteem in which he is held by the members.

Substance in Feed Water.	Trouble in Boiler.	How Remedied.	Resultant. Precipitated.	Resultant. In Solution.
Calcium bicarbonate, $Ca(HCO_3)_2$	Soft scale	Heat	$CaCO_3$	
Calcium sulphate, $CaSO_4$	Hard scale	Heat and Soda Ash	$CaCO_3$	Na_2SO_4
Calcium chloride, $CaCl_2$	Indirectly may cause corrosion	Soda Ash	$CaCO_3$	NaCl
Calcium nitrate, $Ca(NO_3)_2$	Corrosion	Soda Ash	$CaCO_3$	$NaNO_3$
Magnesium bicarbonate, $Mg(HCO_3)_2$	Soft scale and foaming	Heat	$MgCO_3$, $Mg(OH)_2$	
Magnesium sulphate, $MgSO_4$	Indirectly may form scale; corrosion under high pressure	Heat and Soda Ash	$MgCO_3$, $Mg(OH)_2$	Na_2SO_4
Magnesium chloride, $MgCl_2$	Corrosion	Heat and Soda Ash	$MgCO_3$, $Mg(OH)_2$	NaCl
Iron bicarbonate, $Fe(HCO_3)_2$	Sludge	Contact with air and heat	$FeCO_3$, Fe_2O_3, $Fe(OH)_2$	
Silica, SiO_2	Sludge	Filter		
Clay, $H_2Al_2Si_2O_8$	Sludge	Filter		
Mineral acids	Corrosion	Soda Ash		Sodium Salts
Air	Corrosion	Heat		
Carbon dioxide	Corrosion	Heat		
Hydrogen sulphide, (H_2S)	Corrosion	Heat		
Organic and oily acids	Corrosion	Soda Ash	Sodium Salts	

FIG. 2. CHEMICAL RESULTS BY THE HOT PROCESS

THE VILTER ROLLING MILL TYPE CORLISS ENGINE

STARTING in the days when steam pressures were low, speeds moderate and units of comparatively small horsepower, The Vilter Manufacturing Co., with offices at 972 Clinton St., Milwaukee, Wis., began the manufacture of the girder frame Corliss engine about 1880, the days when that was the only type made. It was a good engine and is a good engine today for the purposes for which it was designed, but with the increase in pressures and size of units, changes have been necessary in engines, and first the heavy duty type was designed and now comes the rolling mill type, which has the frame in a single piece with continuous base, with full length of frame and slide, and cast with liberal use of metal throughout. The center line is kept low, as seen in the illustrations, and is arranged for foundation bolts carrying up through the base. In this way the strains are carried direct from piston to crank shaft and the cross strain of the connecting rod is amply provided for.

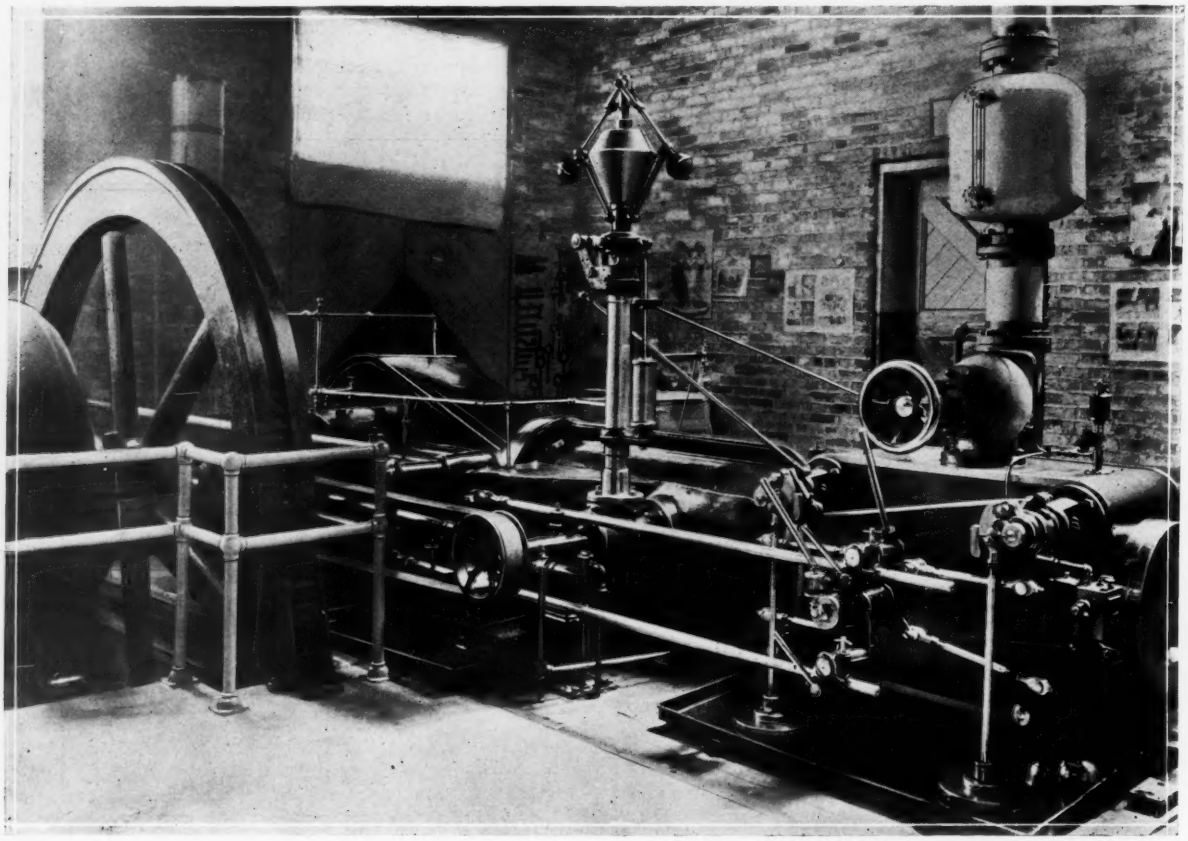


FIG. 1. VILTER-CORLISS ENGINE WITH HEAVY DUTY FRAME, SHOWING LUBRICATING OIL PUMP

In keeping with the heavy design of the frame is the crank shaft of this type, made of hammered open hearth steel with large fillets at the offsets, with crank forced on by hydraulic pressure and strongly keyed, and with crankpin forced in by hydraulic pressure and riveted over; a firm structure is thus produced to transmit the great power which one of the large units furnishes.

Not only high pressures and large powers, but high speeds are also an essential in modern construction, and valve motion and governor of the Vilter engine have been specially designed with this end in view. The governor has the flyball mechanism, but the outward movement of the balls is resisted by a tension spring rather than by gravity. It is the design of Dr. Tolle and is arranged with a vertical cased-in regulating spring, the tension of which can be altered by means of a nut while the engine is running, allowing a variation of 7½ per cent in speed, thus permitting of adjustment for bringing alternating-current generators into step.

The stop on this governor, which prevents its dropping to lowest position when the engine is shut down, is automatically thrown out of position by the throttle valve on opening. This is accomplished by means of a rod running from the stop to the stem of the throttle valve. A cone on the valve stem engages with the end of this rod and throws the stop out of contact with the governor mechanism when the valve is open, thus leaving the governor free to drop to the safety position should the governor belt break.

The valve motion is of simple construction, all parts being in sight and accessible at all times. It will run satisfactorily up to 175 r.p.m., according to size of engine. Large openings are provided in the bonnets to make packing of stems easy, and all parts of the releasing mechanism are heavy and substantial.

A pin on the steam arm engages with the back of the valve arm, thus furnishing a positive method of closing the valve in case the dashpot does not operate.

Knock-off bars are arranged so that they will work without the aid of springs, but springs are used as a matter of safeguard. These bars run on fiber trip cams which are noiseless.

In a number of engines seen in operation at the works of the Kalt & Zimmers Mfg. Co.'s Shoe Factory, Herman Zoehrlaut Leather Co.'s Tannery and George Martin Leather Co.'s Tannery, all of Milwaukee, the action of the valve gear was entirely noiseless except for the exhaust from the dashpots. Trip plates are of hardened steel arranged to furnish 8 different wearing edges and the steam arms are supplied with adjusting screws to insure that the hooks properly catch the dashpot cranks.

Double eccentrics are used, one for the exhaust valves and one for the steam valves, so that proper adjustment can be made for all events in the stroke.

The dashpot is of new style with plunger working inside the casing, therefore dust-proof and requiring but one adjusting screw for each dashpot. This regulates the amount of cushion formed beneath the plunger and the air valve permits the egress of air above the center guide. Connection is made between the dashpot and rod by ball and socket joints so that there is no chance for binding.

In connecting the hook rod to the wristplate a new design of clamp is used in which not only does a notch in the rod fit over the clamping bolt but also the split clamp grips the rod fast. When the rod is released it rides on the clamping pin through the split clamp so that there is no chance for the end of the hook rod to come adrift and do damage.

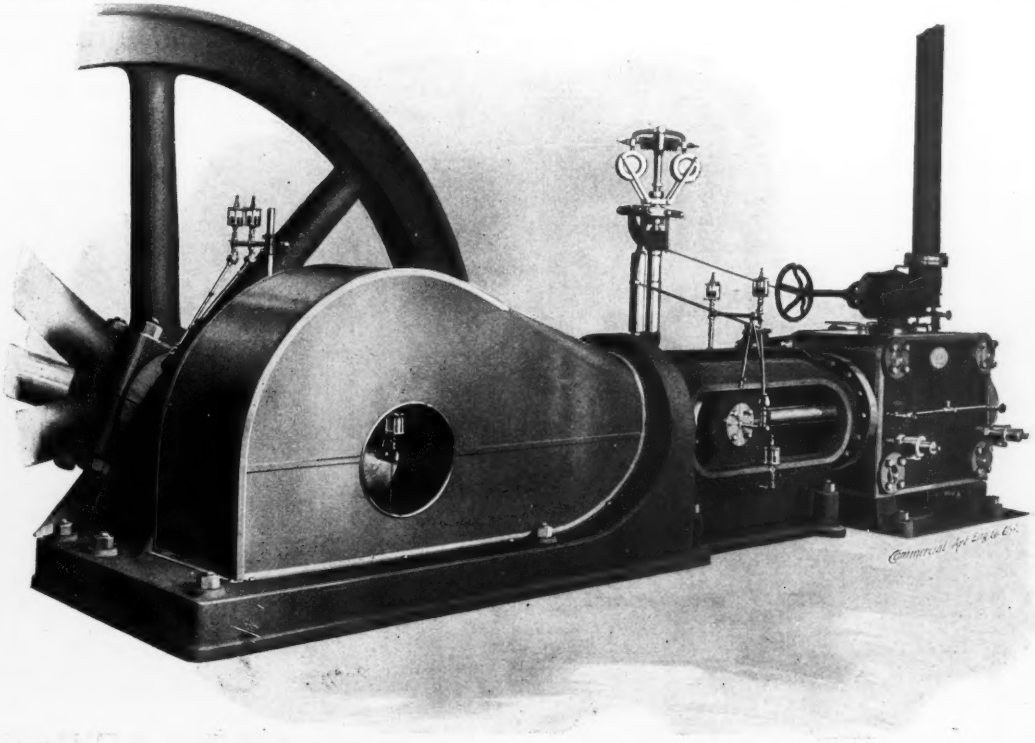


FIG. 2. VILTER-CORLISS, WITH ROLLING MILL TYPE FRAME

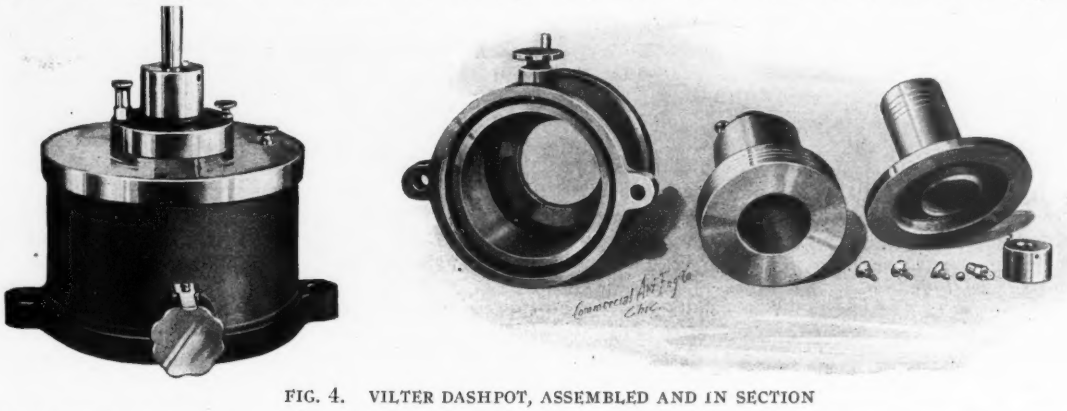


FIG. 4. VILTER DASHPOT, ASSEMBLED AND IN SECTION

The enclosed automatic oiling system is a most convenient feature. Oil from the bearings flows through return pipes to a filter where it is passed through gauze and washed in warm water. It is then pumped by means of a plunger attached to the rocker

arm from filter reservoir to an overhead tank, feeds from this tank through a series of pipes to the different bearings and may be carried in a continuous stream with practically no loss. On a large cross-compound engine the engineer stated that his use of oil was only a pint a month to make up for that lost from the system.

Oil shields are provided over the crank and eccentrics to prevent the throwing of oil at the high speed at which this engine is run, and for parts such as the cross-head, crankpin and eccentrics, the Nugent telescopic oilers are provided.

The band flywheel is usually made in 2 parts, bolted together and where a flywheel is used, as in the case of direct-connected units, the halves of the rim

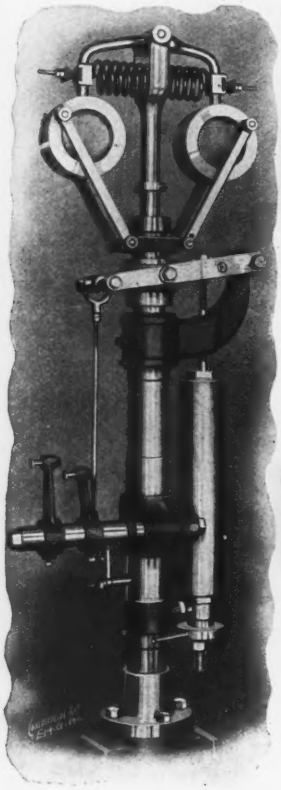


FIG. 5. TOLLE GOVERNOR USED ON VILTER ROLLING MILL TYPE ENGINES

FIG. 3. NEW STYLE VILTER VALVE MOTION

are joined by shrunk links. For direct-connected units the rim is provided with bearing holes and a fulcrum is installed so that the engine can be conveniently turned over. Babbitt-lined crosshead shoes with wedge adjustment are used on both top and bottom, the wear being taken up by the wedge adjustment and the wedges held by set screws. The piston rod is held into the crosshead by a split socket end clamped with bolt and the crosshead pin, which is tapered at both ends, is held in position by a large nut, the end of this pin extending beyond the nut to receive the oiling arrangement for the connecting rod bearing. This connecting rod is of the solid type, the boxes in both ends having wedge take up with a bolt adjustment, and the crank end having a brass box lined with babbitt, while the crosshead end has a solid brass box.

NEW DETAILS OF ROPE SPLICING

By William B. Hosford

MANY interesting experiments in rope splicing have been made in an effort to get a splice that will fill the bill in every particular in connection with the American system of rope driving. A long splice that has so far given the best of results is presented for the readers of Practical Engineer in the accompanying views. The pictures show successive operations in splicing a 1.5-in. 4-strand rope, each paragraph describing an actual operation.

Measure back from the end of the rope the necessary distance, about 7 ft. for 1.5-in. rope, and tie se-

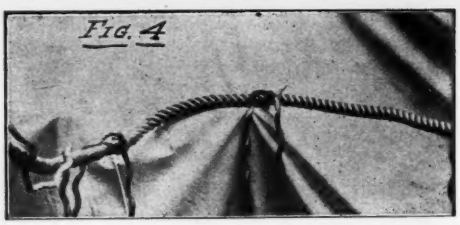


FIG. 1. ROPE UNRAVELED AND TIED, AND CORE CUT OFF
FIG. 2. ENDS BUTTED TOGETHER AND STRANDS PAIRED
FIG. 3. ONE PAIR OF STRANDS MATCHED INTO PLACE
FIG. 4. PAIR OF STRANDS LAID INTO PLACE

curely with a piece of twine, Fig. 1. A good rule for all sizes of ropes is to measure back 60 diameters of the rope to be spliced and tie. Then unlay the strands of each end back to the twine tie.

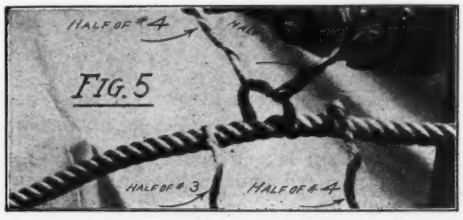
Cut the core close to the end of solid rope and put the core ends together and pair the strands together, as in Fig. 2.

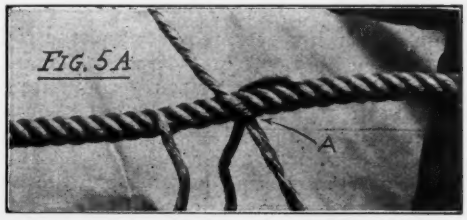
Taking one pair of strands, unlay one and lay in the other until ¼ the strand is laid in, Fig. 3, leaving sufficient end to do the tucking. Then take another

pair, unlay and lay in on the opposite side of the center of splice, leaving your tucking ends.

Now treat the remaining 2 pairs of strands in the same manner so as to leave the 3 spaces between strands the same distance apart, Fig. 4.

From the point of meeting each pair of strands is unlaid 2 full turns back; see the half strands, No. 3 and No. 4, below the rope, Fig. 5. Each strand is now divided equally, one-half of each strand is laid forward to the center of the space between the 2 dropped half strands and tied in a simple knot, so as to have the





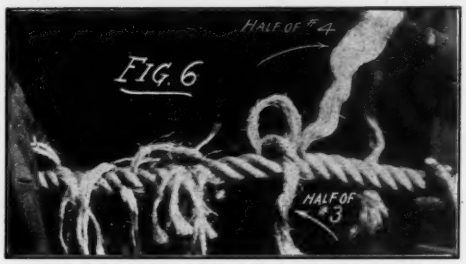


FIG. 5. HALF STRANDS PARTLY AND FULLY TIED
FIG. 6. LAYING IN THE HALF STRANDS
FIG. 7. STARTING THE TUCK

threads running in the same direction as they are running in the rope. See A in No. 5-A after tie is made. The rope is now held and opened with a marlin spike as shown in Fig. 7.

Take half strand No. 3 and lay it around half strand No. 4, until it meets half strand No. 4, Fig. 6. Untwist the threads in the loop as shown and draw them in until the threads run in the same direction as they do in the main body of the rope, as shown in No. 6. Repeat the same operation in the opposite direction, using half strand No. 4 to meet half strand No. 3. This point is now ready to tuck. Treat all strands where they meet the same.

Figures 7, 8 and 9 show the operation of tucking. Now cut half strand No. 3 for convenience and take out one thread and one thread out of No. 4, or the tucking strand, insert the marlin spike so as to open the strand, holding the rope as shown. Pull the remaining threads of No. 3 out from under B, making room for No. 1. Draw half strand No. 4 over and under, taking the twist out of threads, as shown in No. 8, pull down firmly in the direction the strands run in the main body of rope. Continue to repeat this operation, dropping a thread out of each half strand until all the threads are dropped. Treat all strands alike, when rope will have appearance shown in Fig. 9.

Now, cut the threads off close to the body of rope, which gives it the appearance of Fig. 10.

In splicing a 3-strand rope the operation of measuring back, tying, unravelling and butting together is the same as in a 4-strand. There is one pair of strands

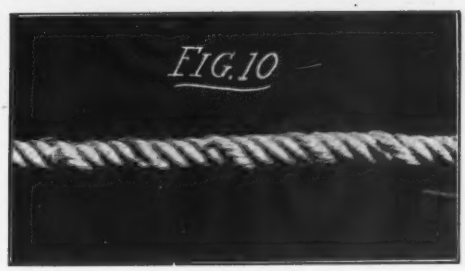
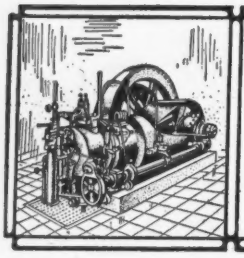


FIG. 8. WORKING THE HALF STRANDS AROUND AND TAPERING OFF
FIG. 9. THE TUCKING COMPLETED
FIG. 10. TRIMMED UP READY FOR WORK

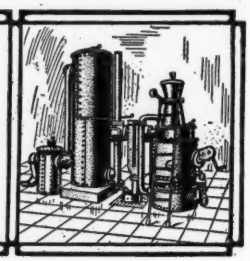
less and you lay out one pair of strands in each direction, letting a tucking end and one pair of strands remain in center. Every other operation is the same as a 4-strand rope.

PROF. W. F. SCHAPHORST of the Mechanical Engineering Department of the New Mexico College of Mechanic Arts has resigned his position there to become a technical writer on the staff of A. Eugene Michel, Advertising Engineer, New York City.



Gas Power Apparatus

Producers, Engines and Industrial Applications



THE GAS ENGINE AS A PRIME MOVER

By C. F. Swingle

THE gas engine is a prime mover which derives its energy or power from the heat produced by the combustion within its cylinder of a mixture of gas and air in the proper proportion to form an explosive.

Combustion of this charge of gas and air occurs while the charge is under a close or heavy compression caused by the inward movement of the piston after the charge is admitted, and all the valves are closed. The result of igniting this mixture under a heavy compression is what is usually termed an explosion which is in fact, really nothing more nor less than a quick burning, or rapid combustion of the mixture. This sudden explosion causes a high degree of heat within the cylinder, behind the piston, and the resultant high initial pressure against the piston drives it forward, and, through the medium of the connecting rod and crank, motion is imparted to the engine shaft.

Why Large and Heavy

IN 2 important structural features the gas engine differs from the steam engine; first, it is much more ponderous than a steam engine of equal output; and second, it usually has a much heavier crankshaft. The difference in total weight, however, should not be laid to the higher mean pressures exerted in the cylinder, for, in engines of equal power capacity the mean pressure in the gas engine cylinder will be higher than that in the steam engine cylinder, so that for a given power per stroke the gas engine may have the smaller cylinder.

The necessity for the larger dimensions, and heavier weight of a gas engine as compared with those of a steam engine of equal horsepower is due to the fact that the gas engine has only one working stroke in four, or as is the case with the more modern and improved types of 2-cycle engines, one working stroke in 2. For a specified power, therefore, the piston area of the gas engine must be 4 times the area of the piston of the steam engine per pound of mean effective pressure. Since this latter will be as 3 to 2 approximately, the actual cylinder area will be as 2.66 to 1, or the diameter ratio will be as 1.63 to 1.

Demand for heavier weight in the crank shaft of the gas engine is due to the difference in stress to which it is subjected. For instance, a single acting engine produces a torsion in the shaft which is reversed on the next or compression stroke, when the crank is pushing the piston. Reversing stresses are about 50 per cent more destructive than stresses in one direction only. The ratio of crankshaft strength is thus not simply 4 to 1 as between a 4-stroke and a 1-stroke method of working, but it is in fact as 6 to 1, or diametrically as 1.8 to 1, the strength varying as the cube of the diameter.

Two vs. Four-Stroke Cycle

THE fact that a gas engine appears approximately fully 50 per cent larger than does a steam engine, when its piston speed and output are the same, is a strong inducement for the designer to produce a gas engine which shall do work in both ends of the cylinder.

Such a design, however, requires a piston rod stuffing-box, gland and cooling devices. It involves double the number of explosions per minute in the cylinder, but it renders possible a reduction of the cylinder ratio as compared with a steam engine, to 1.33 to 1. The original gas engines, and a majority of the smaller sizes at present operate upon the Beau de Rochas cycle, or 4-stroke cycle, sometimes termed the Otto cycle, the meaning of which is that the engine completes a cycle in 4 acts explained as follows:

(1) Induction: During an out stroke of the piston, air and gas in the proper proportions are drawn into the cylinder.

(2) Compression: The following instroke compresses the combustible mixture into the clearance space.

(3) Explosion: Ignition of the compressed charge causes a rapid rise of pressure, and subsequent expansion of products which, acting upon the piston, causes it to move outward on its work stroke.

(4) Expulsion: The expanded gases are expelled by the returning piston.

In this type of engine 2 revolutions of the crank shaft are necessary in order to complete 1 cycle. Many small engines, and some of those of largest power are designed upon the 2-stroke cycle which is as follows:

(1) Compression of the charge.

(2) Ignition, explosion and expansion, and at the end of the outward, or work stroke, the exhaust products are expelled, and the cylinder is again filled by the mixture of air and gas under pressure.

In the 2-cycle gas engine, 2 compression chambers are necessary, due to the fact that in this type of engine, which consists of 2 cylinders placed either side by side or tandem, the charge of gas and air is being admitted to one cylinder, at the same time that the previous charge in the other cylinder is being compressed preparatory to explosion. A 2-cycle engine thus explodes a charge, and receives an impulse at each revolution.

It is important to admit only pure air and gas into the cylinders of a gas engine. Dust and grit, or tarry matter cause rapid wear of interior surfaces. Care should be taken to insure the induction of cold charges, in order that the maximum density of gas and air may be obtained.

Combustion

IN gas engine practice the speed of combustion should be neither too rapid nor too sluggish.

A great deal depends upon the relative constituents of the particular gas used. If hydrogen is present in large quantities, there will be a tendency toward premature ignition from the heat of compression owing to the fact that hydrogen burns with great rapidity, its rate of combustion being 7 times higher than that of methane. But a permanent power gas for use in gas engines may contain a high percentage of hydrogen, if it be modified by the presence of large quantities of the more sluggish and inert gases, such as CO_2 and nitrogen, the tendency of which will be to retard combustion.

In this way a suitable power gas may be obtained. On the other hand, if a sufficient high percentage of heavy hydrocarbons, and sluggish constituents is not present, compression in the cylinder must be largely reduced. Thus blue water gas (uncarburetted) is not adapted for use in a gas engine, but when mixed with oil gas, in other words, carburetted, it becomes more suitable. The same may be said of crude oil water gas.

In the usual form of byproduct coke ovens, the richer gases are drawn off during the first half of the coking period, as for instance, during the first 10 hr. of a 24-hr. coke, or the first 16 hr. of a 30-hr. coke. In the gases given off during the latter half the percentages of methane and hydrogen are rapidly reversed, the hydrogen running as high as 60 or 70 per cent of the total volume.

This makes the gas unfit for power purposes, but it is used for heating the ovens. The delivery of coke oven gas must, therefore, be carefully controlled if it is to be utilized for the production of power in the gas engine.

PRACTICAL SIDE OF GAS PRODUCERS

By E. N. Percy

SEVERAL practical men of first-class ability in their lines have been asked why they did not interest themselves in gas producers with an idea of taking up the opportunities in that direction. A number of them said that they had endeavored to do so, but found any information available so involved in technical formulae that the plain principles could not be grasped by a practical man; on the other hand, so-called practical works, while describing the practical operation of the producer, did not make sufficient reference to principles and reasons for things that were done; and the intelligent engineer always wants to know "why," even if he is not up to high C on technicalities. This article is intended as a plain talk to plain men, by a plain man, who has had many hard swats in the practical producer business, including their design and operation, and many profane hours spent in the development of new or experimental devices.

With an ordinary coal or coke fire, under a boiler or elsewhere, the fire may be 6 to 16 in. thick according to draft, kind of fuel, etc., and the gases arising from the top of it will be noncumbustible, consisting mostly of carbon dioxide, nitrogen and moisture. The carbon dioxide is a direct result of the burning of the coal. The nitrogen is already in the air, and is not affected by the fire. The moisture is partly formed from the hydrogen in the coal and the oxygen in the air, and part of it is merely dried out of the coal.

If the fire be several feet thick, however, we have a very different condition. The gases coming off of the top are combustible, and valuable as a means of power with gas engines, or to use in furnaces, etc. They consist principally of carbon monoxide instead of dioxide, hydrogen and some coal gas, such as is in our city pipes. It is a very weak gas, and burns with a thin blue flame, when clean; but is valuable for power purposes, because it can be produced so cheaply. It is the only way that coal can be utilized in gas engines, as about 85 per cent of the heat in the coal is delivered to the engine.

Ordinary coal gas for lighting and heating cities is made in a different way altogether by heating coal in a retort until all the heavy or "hydrocarbon" gases are driven off, and only the coke remains. This coke cannot be used, and has to be sold; also, it takes a great deal of heat to make gas this way, so that it is a very expensive process, too much so for large power; also, the gas is high in hydrogen and liable to preignite in an engine with sufficient compression to be economical. Also, this gas requires a great deal of scrubbing and cleaning because of the tar and lamp black in it.

Fuel Bed Conditions

TO return to producer gas—the producer can use a very poor grade of coal, but must be designed for whatever fuel it is to use. There is no residue, such as coke, but the entire contents are burned to ash, as with an ordinary fire. The gases come off at a temperature of about 700 to 1000 deg. F. This heat is always utilized in some way. If the gas is to be burned in a furnace, the gas is simply run into the burner as hot as possible; if used in an engine, it is either used to heat up incoming fuel, or to make steam; which brings us to another subject.

It has been found that if steam goes into the producer with the air draft, that a better, stronger gas is produced, that there is less nitrogen from the air, and more hydrogen, which is a good quality if not carried to excess. Also, the fire does not clinker so badly, and it is much easier to poke and handle. The height of the actual fire or combustion zone varies with the kind of fuel, strength of draft, etc., but is never less than 18 in., and may be as much as 5 ft. A fair average with anthracite coal is 3 ft., although it is possible to make gas with a mild draft at 12 in., or even less, if the lumps are not too large so as to let free air pass through. Without steam, the hottest part of the fuel bed, which is, of course, where the air first strikes it, is a brilliant white heat. With steam, it may be anything down to a dark orange, below which color, it is not likely that gas can be generated; but with steam, the fire will be much longer, and much cooler at the bottom, and hotter towards the upper half.

Practical Difficulties

THEORETICALLY, it is easy to make producer gas, but all of the difficulties are of a practical nature, and will eventually have to be solved by practical men, as the chemistry is easily accomplished, although of a complicated nature. The most important thing about

a producer is to have absolutely fixed and regular conditions. Let the same amount of gas be made all the time, and the same amount of air forced through, the same amount of steam put in, the same amount of fuel added, and the fire poked down, and kept compact at all times, and the ash regularly removed, and it is the easiest thing in the world to make good gas of a uniform quality and with all the power that could be wished for; but these conditions are almost impossible to obtain as we shall see.

First, take the fixed and regular conditions in connection with the manufacture of a uniform amount of gas; a gas engine requires varying amounts of fuel with varying loads. Small engines, sucking from the producer can be governed by hit and miss, and the gas will pass through uniformly, making uniform conditions in the producer, but this is entirely too wasteful a method for engines of any size, and is too jerky a method of governing for any duty requiring closeness of regulation. Many suction gas plants are in actual and satisfactory operation under varying loads and governed both ways but much is to be wished for in connection with their absolute reliability.

The largest plants of the most modern type are operated with a positive quantity blower, and the gases stored in a holder, to be used as needed. Some large and successful manufacturers operate large engines directly connected to producers both with and without assistance of blowers; but it is the writer's personal opinion that the future success of the gas producer lies along those lines which produce the nearest to absolutely uniform conditions in it.

Where an engine, as a marine or pumping, is operating under constant load, it is permissible to connect it directly to the producer; but even then, it would insure safety, if the extra gas were blown off, when starting, stopping or maneuvering, instead of attempting to change the rate of production in the producer. In connection with this, it should be noted that a producer will come down from full load to as little as one quarter with no signs of distress, but after running for a long time at small load, it has to be brought up to full load very gradually; if this is not done, the gas will gradually "peter" out in quality, owing to excess of unoxidised air, due in turn to shortening of the incandescent zone, and the engine will stop, until the incandescent zone is again of sufficient length to produce gas at full draft and load.

Take now the forcing through of the same amount of air under all conditions. As a rule, only small producers are worked by suction from the engine, although some large ones are, and a number of manufacturers utilize both engine suction and a blower. The objection to engine suction alone is that if the fire becomes caked or clinkered the charge becomes so rarified (the suction can easily run up to 30 in. of water) that the engine develops scarcely any power, which is one reason that good fuel has to be used in small suction producers; also, small producers can get better attention and poking than large.

Steam Supply

MANY of the best producers have for years used a steam jet blower; but this does not give a constant amount, and the pressure varies with blast, and the condition of the fire. An ordinary fan is open to the same objection, although both of these give good practical results, when all other conditions are such as to keep the producer in fairly regular condition, and the fuel bed is carefully poked and broken up at regular intervals. In either case, the producer may discharge into a receiver, or directly to the engine.

It must be understood that the gas has to be scrubbed before it can be used or stored, and this subject will be taken up later. The positive drive blower, discharging into a receiver, has given the best satisfaction in regard to uniform gas. The economy of most producers is unquestioned, but we are in sore need of absolute reliability, and it seems as though the surest way to approximate this is to measure out each constituent by positive machinery, leaving nothing to possible conditions. Experience and practice have given the most success where these things have been done.

Take now the matter of keeping the steam in a given proportion to the air. This is a very difficult thing to do. Some makers have a drip cup which is governed by the suction of the engine, and drips water into the vaporizer heated by the hot gas, or the engine's exhaust. As a rule, neither one, alone, can furnish all of the steam that the producer can use to advantage; but when some of the engine jacket water is further heated by an exhaust heater, and then dripped into a gas heater, and the air is pre-heated in a jacket around the producer, plenty of steam is formed.

Some producers have a jacket around the upper part of the fire zone, in which water is boiled away, in which case plenty of steam is formed, but the heat is abstracted from the fire where it can be doing good work, although it is again returned to the fire, the waste heat of the gas is not utilized, and is wasted in the scrubbers. In general, dripping devices are only partially satisfactory, because their effect upon the gas is only felt some moments after the governor acts upon the engine, by which time an entirely new condition may have arisen.

Other makers use instruments that measure or control the humidity of the air entering the producer, but they depend upon temperature, which is difficult to control in relation to humidity, or weight of ingoing blast, irrespective of temperature, and while these appliances are in actual use upon very successful producers, the writer has seen these producers work continuously with equal success when the instrument was disconnected.

In order to use a steam jet blower, it is necessary to have steam from a separate boiler, for which the feed water may be heated by hot gas or exhaust, but they are seldom hot enough to generate actual pressure; also, the steam is needed to start producer and engine, before there is any heat at all. The latest practice is tending towards utilization of heat in hot gas and engine exhaust to vaporize a measured amount of water dripped onto properly designed vaporizers, and mixed with the positive quantity of air driven in with a positive blower. The amount varies with fuels and conditions, some moist fuels requiring none, but average coal or coke requires about 2 lb. per horsepower hour. Most producers use less steam, or rather make less steam, than they might make use of.

Care of Fire

TAKE now the working of the fire, the removal of ash and the feeding of fuel. It has been generally conceded without argument that the fuel must be fed regularly. Most makers do this by merely making the producer so very tall that a column of cool coal lies above the fire proper, and gradually sinks down into it. Some makers take the gas out at the top of the fire zone, others let it go up through the column of

coal, and give off its heat to it, which in many ways is an advantage and a saving; but when this practice is carried into large producers, it is found to render the poking of the fire almost impossible, and the center of the fire cannot be reached at all, resulting in cavities, clinker, cakes of coal, and other evils of a poorly worked fire which tend to weaken the quality of the gas, and make the fire zone of irregular height. The best practice with large producers indicates those devices which feed the coal constantly in a thin shower, equally distributed over the top of the fire, and leaves the top of the fuel bed entirely open to poking or such other attention as it may need; also, a man can tell more about the condition of the producer by the top of the actual incandescent zone than by any other one thing.

As to the working of the fire and removal of ash; few producers have enough poker holes. All producers should have poker holes in the top, and down all sides, that the fire may be seen and worked from all points. It is far easier to work a little from many points than to drive great bars in from above, over the heat of the producer, and be half suffocated with gas, and only half know what one is doing.

The removal of ash is accomplished in many ways. Some producers have ordinary grate bars, and the ash is raked and poke down between them, and clinker left until the end of the week, others have revolving tables which gradually throw off the ash, and, to some extent settle the fuel bed and keep it compact. Others have a water seal at the bottom, and the ash is raked out from under the water once or twice a day.

The writer has outlined a plan requiring considerable development overcoming some of this work. It consists of a producer so constructed with water seals at top and bottom as to itself revolve slowly, with a slight rise and fall. This would keep the fire around the edges from cavitating, where it usually occurs. The edges would be kept fairly well packed, and clinker would not adhere to the sides, on account of the continual grinding. The slight rise and fall would settle the fuel around the edges where it usually gives trouble by hanging, and as there is a constant motion, only a few side holes would be required to poke the fire from all points, and the bricks would last much longer, because there would be less clinker to knock off; but the principal thing would be to eliminate the heaviest part of the poking.

The revolving table, while a fine thing, only agitates the middle of the fire which needs it least, while this plan would agitate the edges where 9/10ths of the work, and all of the hard work is done. Also, with a revolving body, all fuel spreading devices are unnecessary, because the various parts of the fuel bed are gradually revolving, and it is only necessary to feed the coal in from some sort of automatic hopper, of continuous feed type. Also, the ash would be automatically and continously discharged.

Types of Producers

THERE are many types of producers, and the practical man is referred to any descriptive book on the subject, or the catalog of the many excellent makers of this country and Germany. The main differences are direction of draft, whether up, down or crossways. An ordinary up draft producer will produce a great deal of tar and pitch when used with soft coal, and this has to be scrubbed out at great expense, or it will clog up the engine.

The down draft is intended to pass these tars, etc., through the red hot fire, and burn them up into gas, lamp black, etc. If there is not too much tar, they are successful, but as the hottest fire is at the top, the ash and clinker collect there, and must go down through the fire bed, gradually increasing in quantity, and thinning out the fuel, and making, on the whole, not the best gas. There are many of them in actual successful operation, but either the clinker must be removed at the top, a hot, nasty job, or the ash must be removed at the bottom so fast that considerable fuel is mixed with it, reducing the economy. In general, it may be said that the down draft is not as perfectly developed as the up.

Rate of Combustion

IT has been known for a long time that the gas producer works most reliably at low rates of combustion. Combustion in a gas producer may be measured by about the same standards as a coal fire elsewhere. They will make gas on anything from 4 or 5 lb. of coal per square foot of grate per hour, up to 40 lb.; but over 15 to 20 lb., clinkering and tar troubles begin to manifest themselves. Also, a long fire with a heavy draft is much more sensitive to changes of steam, etc., than slower combustion, also, it clinkers, cavitates, and cakes quicker than the slower fire. Hence, we may expect all kinds of ratings for producers, ranging from the conservative rating of the high grade article to the rating of the highly competitive article that will devour fuel and its own lining with equal avidity.

The writer urges that the practical man makes sure, above everything else, that there be no point of his producer that he cannot reach with a bar at any time, and reach it sufficiently to do actual work, and lots of it. The writer has never seen a balky producer but what a thorough shaking down and cleaning would not start it right up, provided it could be given; and he has never seen a balky producer, (provided it was a developed article) even under variable load, where the fire could be reached and worked. The writer has seen the worst fuels (for instance, peat and slack) that were condemned by experts, gasified in an ordinary producer, by simply barring and working them in a manner that was practically continuous, and a producer in which the fire was accessible.

Producers use various fuels, including anthracite, soft coal, lignite, peat, sewage, garbage, wood, etc. They have to be specifically designed for each fuel, and standard books contain the description of each. Liquid fuels have not yet been gasified in any economical or efficient manner; although in localities where their production is extremely cheap, they are used in large quantities, and gasified by processes similar to the production of coal gas for illumination, which are very wasteful; indeed, the oil can be burned under a boiler and the power produced more cheaply.

A gas producer and engineer will generate a horsepower on a pound of low grade coal or slack, while a good steam plant of the highest type requires 2 lb. of good steam coal. Also, a small producer plant, entirely without auxiliaries is just as economical as the largest.

The scrubbing of the gases is simple. They are merely passed through a body of wet coke or, in some cases, a scrubbing machine, and then go to the engine. With dirty gas, it is scrubbed several times. There are many text books on this subject that are easily understood, and there are no technicalities involved in the scrubbing of gas, unless one takes up the question of saving by-products.—Gas Review.

APPLICATIONS OF LOW-PRESSURE TURBINES II

VARIOUS PHASES AND ARRANGEMENTS FOR SPECIAL CONDITIONS

By Edwin D. Dreyfus

MANIFESTLY a positive interlocking of the low-pressure turbine with the main engine must be effected in order that direct compounding with the engine may be accomplished. In electric generating stations, the problem is immediately solved through generators of identical characteristics, the synchronizing force, in alternators particularly, establishing a certain bond. In mechanically driven mills, the absence of an immediate coupling of the engine and low-pressure turbine has been circumvented through the provision of a synchronous motor connected with the same shafting as the engine and running in parallel with the turbine alternator.

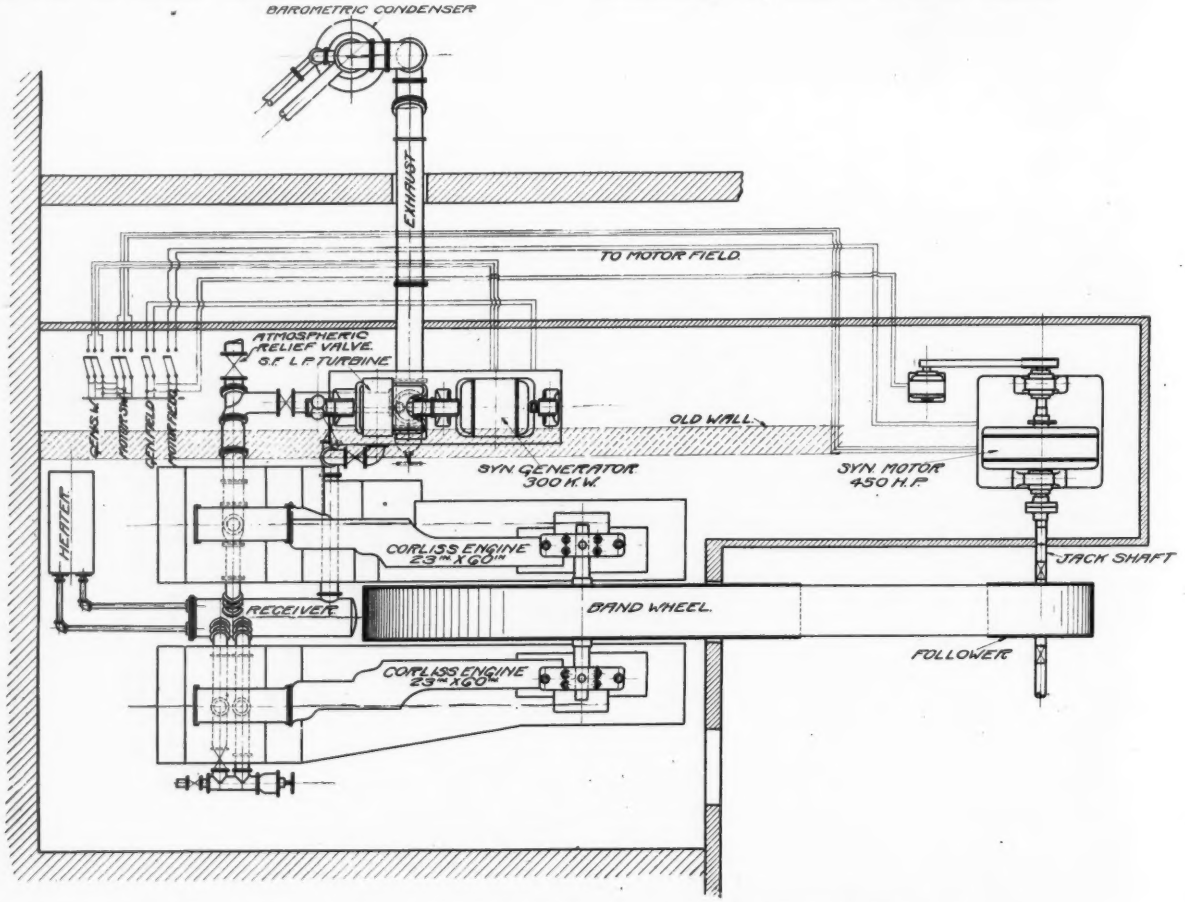


FIG. 4. SYNCHRONOUS MOTOR USED TO TIE ENGINE AND TURBINE TOGETHER

A representative layout of this type of installation is shown in Fig. 4, in which all essential apparatus is included. The main advantage in this arrangement is the interchange provided of load between the engine and turbine. As pursued in a number of later installations, an external electrical load may also be supplied to the extent of 75 per cent of the capacity of the turbine and motor. In this way the synchronous motor may serve alternately as motor or generator.

Through the joint electrical and mechanical coupling, the governor for the turbine may be omitted, all regulation being accomplished entirely by the engine. Here the turbine inlet and engine back pressure automatically adjust themselves with the load, contributing towards the best mechanical and electrical performance.

Recording vacuum and intermediate pressure charts, Fig. 5, obtained at the Bernon Mills plant, illustrate that on light loads the pressure between the turbine and the engine falls below atmosphere, assisting the economy without prejudicing the vacuum because of air leakage. It will be noted that with about 12 in. vacuum at the turbine inlet, the condenser was maintaining very close to 29 in. of vacuum.

Widely Distributed Engines

IN the early period of the development of the low-pressure turbine field, it was deemed requisite that the source of exhaust supply be fairly concentrated and adjacent to the most desirable location for the turbine. This was especially so with a diversity of small engines; but through accurate analysis, attractive economies have been revealed at several industrial works which have inagurated installations of extraordinary interest.

An example is diagrammatically shown in Fig. 6, in which case the exhaust of 13 widely separated non-

condensing engines has been conserved and delivered to the low-pressure turbine, Fig. 7, located in a central power house through the extensive "tributary" piping system illustrated. The value of the low-pressure turbine thus becomes significant when an additional output of 1000 kw., as shown by the graphic charts, is generated without increased expenditure in fuel.

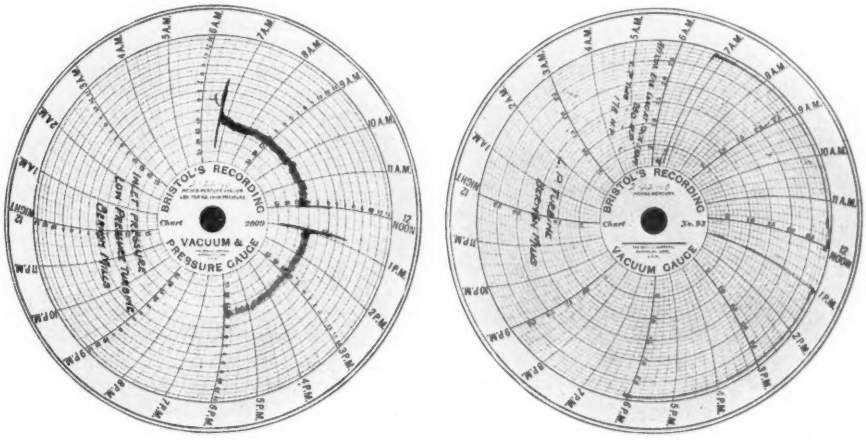


FIG. 5. RECORDS OF TURBINE INLET AND CONDENSER PRESSURE, BERNON MILLS

Conservative estimates show that an electrical horse-power year with these conditions of operation is being produced in the low-pressure turbine plant at $5.50, including all charges. With coal varying from $1 to $6, corresponding power costs, in an equivalent high grade condensing steam station, would range from $16 to $45; and from $22 to $35 in a gas plant for the same conditions and range of coal prices.

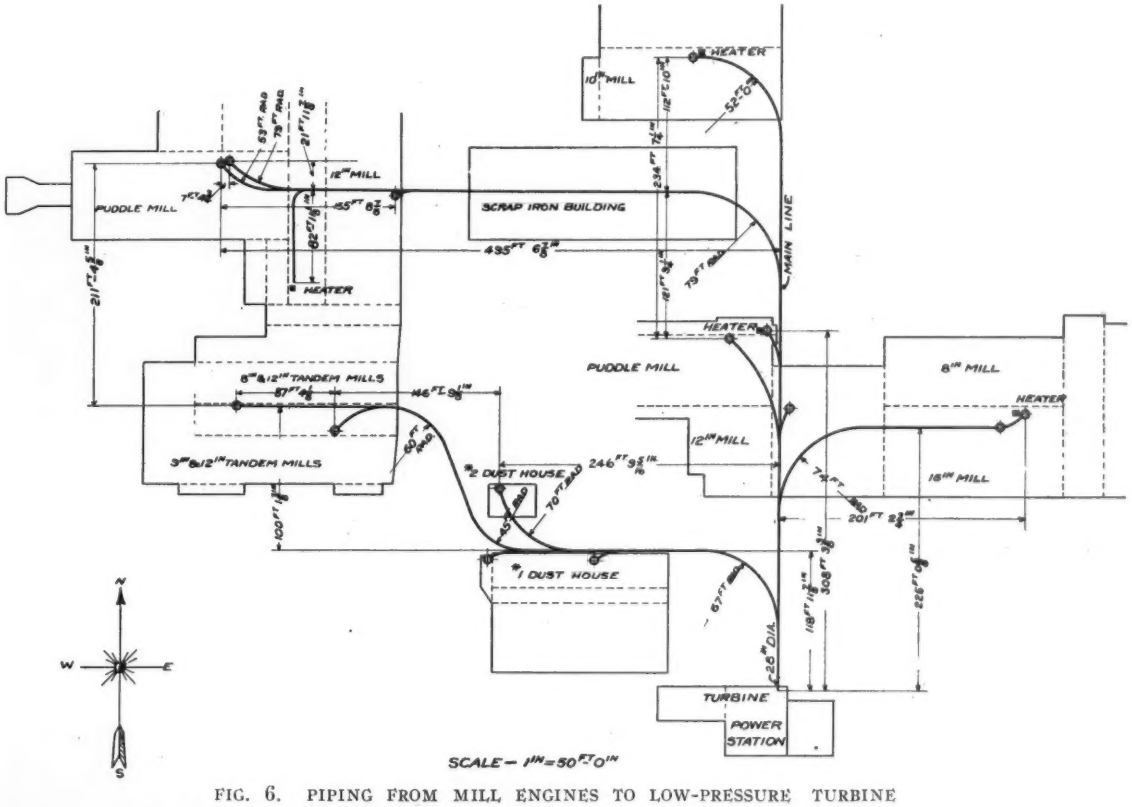


FIG. 6. PIPING FROM MILL ENGINES TO LOW-PRESSURE TURBINE

This system comprises 2475 lineal feet of piping, varying in diameter from 5-in. feeders to a 28-in. header, terminating in a large oil and moisture separator 8 ft. in diameter and 16 ft. in depth, shown in Fig. 8. Suitable expansion joints are provided at required intervals, and all piping is carried overhead, lagged, and supported on pipe frame work.

Turbine Not Consuming Entire Exhaust

THERE are specific cases where the low-pressure turbine may be profitably installed in connection with a reciprocating engine condensing plant without the entire amount of engine or pump exhaust being utilized in the turbine. If the surplus steam over and above the quantity required by the turbine during any

period be permitted to escape at a predetermined pressure, a certain loss in energy would be occasioned, which might otherwise be avoided through the medium

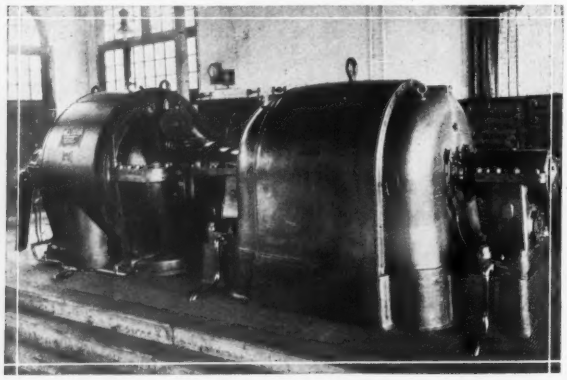


FIG. 7. TURBINE PLANT OF FIG. 6 SYSTEM

of a partial vacuum produced on the high-pressure apparatus.

To satisfy this requirement, a governing system has been developed for low-pressure turbines, which controls the flow of exhaust steam in such a way as continually to deliver to the turbine the amount of steam necessary to carry its load and to bypass to the condenser any existing excess.

Manifestly the back pressure on the engine always corresponds with the turbine inlet pressure which, in turn, is proportional to its load. Consequently, that part of the steam passing through the turbine, is used with a relatively high degree of efficiency, while the remainder is throttled through only a small range in pressure by the governor valve, occasioning a minimum loss from free expansion of the excess steam.

Advantages of this method are: (a) Ability to apply a low-pressure turbine to high-pressure apparatus with different load characteristics economically. (b) It obviates the necessity of having the high-pressure engines operate continually at the back pressure required to carry maximum load on the turbine, as in the case of governor controlling only the supply to the low-pressure turbine. With the latter type at loads less than rating on the turbine, the excess steam would escape at relief pressure, entailing a corresponding loss in energy. With the new valve it will, therefore, be unnecessary to cut the engine serving low-pressure turbine in and out to accommodate the load on the turbine. (c) Extension of existing capacity to secure high efficiency in the new and old equipment. (d) Simplification of station arrangement; less piping and floor space; one condenser for steam passing through high and low-pressure elements.

The first 2 items are peculiar to this system of governing, while the last 2 are common to all.

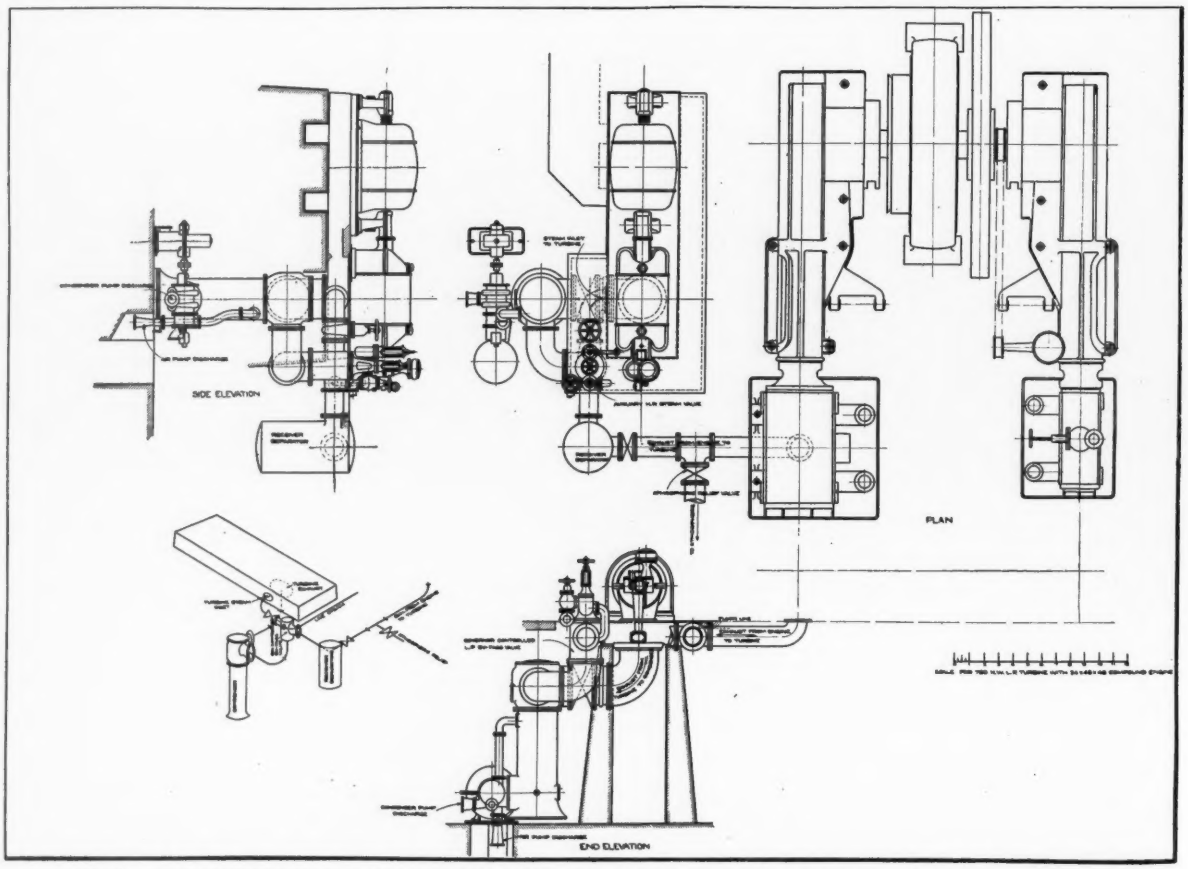


FIG. 9. ARRANGEMENT OF PLANT FOR GOVERNOR CONTROL OF SUPPLEMENTARY LIVE STEAM SUPPLY TO TURBINE AND EXCESS ENGINE EXHAUST DIRECT TO CONDENSER

Arrangement plan for a turbine installed to operate on the exhaust from a cross-compound, direct-current unit, is shown in Fig. 9, which, giving plan, side elevation and end views, explains the principal features, as

clearly indicated in the isometric drawing in the lower left hand corner, Fig. 9.

Economy

THIS method of operation is best suited to cases where high-pressure units operate at practically constant load, or a system of engines, pumps and compressors, exhausting in the aggregate, a nearly uniform supply of steam.

If the turbine does not constantly require all the available exhaust from the high-pressure units, the latter may be made to reap the benefit of reduced back pressure when the turbine is carrying a light load. A turbine at no load would require an inlet pressure of

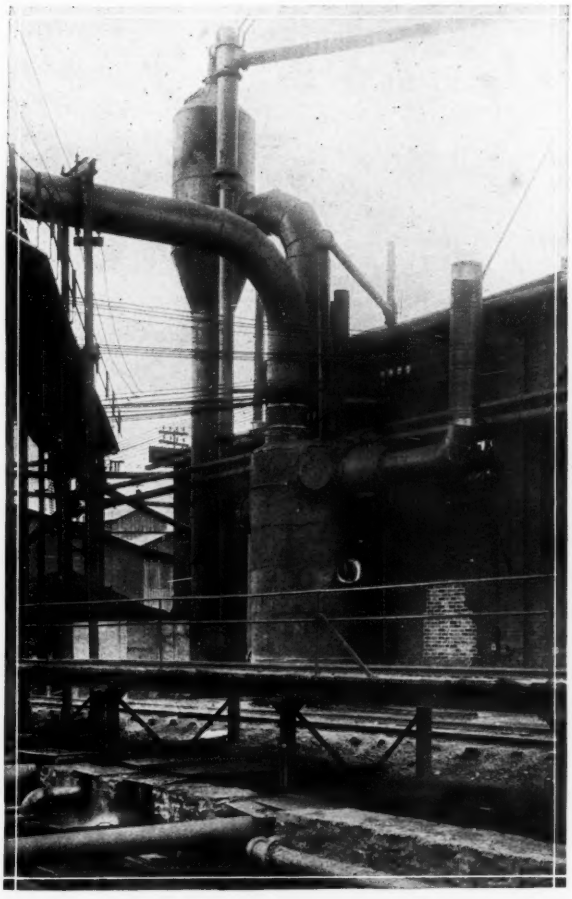


FIG. 8. OIL AND MOISTURE SEPARATOR ON TURBINE SUPPLY LINE

about 5 lb. absolute for a vacuum between 26 and 27 in., and correspondingly lower for higher vacuum. As the important feature of bypass governing is to maintain automatically a pressure in the exhaust line from the engine equivalent to the required inlet pressure at the turbine, the engines would then exhaust at about 5 lb. absolute when the load falls off on the turbine. It is safe to say that the gain of the simple engine will be virtually proportional to the decrease in back pressure.

Illustrating: Since a simple engine should have a mean effective pressure of 50 lb. each pound reduction in back pressure would produce an improvement close to 2 per cent. As the back pressure will be lowered 10 lb., approximately, when the turbine is carrying no load, the corresponding betterment is roughly 20 per cent. Hence, between the limits of the low-pressure turbine taking its full-load steam and producing over 100 per cent better results, and its no-load consumption, a fuel saving will be consequently made, varying from 20 per cent to 50 per cent.

The foregoing discussion mainly applies to small apparatus where the saving must necessarily be considerable, in order to have any material effect upon the general economy of the plant. Where large units exist and fuel is an appreciable factor in the cost of power, the low-pressure turbine, with bypass operation, may introduce important economic returns.

Such cases occur principally in connection with existing d. c. railway power plants where extension becomes necessary for outlying rotary substations. The service in the bordering and sparsely settled territory, is naturally infrequent in comparison with important streets and centers. Consequently, the a. c. low-pressure turbine units would operate on a comparatively variable load, and the bypass system will thus effect the most economical station results.

At present the prevalent type of blowing engines in the steel mills has compound Corliss cylinders. It is practible to install this particular low-pressure turbine system to furnish the varying power requirements of the mills and operate with high economy in connection with the constantly loaded units.

In low-pressure turbine installations with bypass governors it is not necessary that the turbine be large enough to utilize all the exhaust of the engine at, say, atmospheric pressure. The most desirable intermediate pressure and the percentage of the exhaust to pass through the turbine is, to a great degree, elective.

(To be continued.)

SELECTION OF state mine inspectors by popular vote is obviously poor policy and the statement by Dr. Joseph A. Holmes, director of the Federal Bureau of Mines, made before the Case School of Applied Science that this method of selection should be stopped will meet with hearty approval of everyone familiar with the duties of such inspectors. It is quite evident that the lives of miners must depend for safety largely upon the conditions in the mine and these conditions are determined by the inspectors. What business a politician has in saying who is qualified to make a mine inspector is beyond the conception of any man who has to do with the handling of machinery or with the up-keep of mines. Methods of using explosives, handling of gases and coal dust, mine timbering, preventing and extinguishing mine fires, rescue and first aid work are matters about which politicans or even the average voter has very uncertain, if any, ideas. The state mine inspector should be a man carefully chosen for his fitness for the work, insured permanence of office and freedom from political influence.

IN VIEW OF THE enormous loss from fire which takes place every year, the exhibit of fire-proof methods of building and slow-burning construction, such as will be made at the National Building Material Exhibition in Madison Square Garden, New York, September 9-16, will be of interest to all who have to do with building construction, especially those who are contemplating the building of factories or power plants. There will be a chance to study materials and methods of using them to secure the best results and to secure desirable effects.

STEAM TURBINES FOR DIRECT CONNECTION TO MODERATE SPEED MACHINERY

COMPARATIVELY little progress has been made in the adaptation of the large size steam turbine for direct connection to machinery of moderate speed such as centrifugal pumps, blowers and direct-current generators, or for driving machinery by means of ropes or belts. The difficulty has arisen from the velocities involved, for the expansion of 1 lb. of steam from 150 lb. pressure (164.7 lb. absolute) to a 28-in. vacuum sets free for doing work 252,850 ft. lb. of energy, and if the expansion be accomplished in 1 nozzle, the resulting velocity of the steam will be 4040 ft. a second.

Force on Buckets

IF a jet of steam strikes upon a bucket which is standing still, it will exert a force equal to the weight flowing per second divided by the acceleration of gravity (32.2) and multiplied by the velocity with which the steam strikes the bucket. The jet leaving the bucket will cause a reaction equal to the weight per second divided by the acceleration of gravity and multiplied by the velocity with which the steam leaves the bucket.

If the bucket moves, the forces exerted will be the same in nature as before, but the velocities involved will be those of the steam relative to the bucket, that is, the total velocities of the steam on entering and leaving minus the velocity of the bucket. If the bucket velocity increases until it is equal to the velocity of the steam in the direction of motion of the bucket, there will be, of course, no force exerted on the bucket and if the velocity of the bucket is ½ that of the steam, there will be no change in the relative velocity of the steam to bucket and the work done by the steam will be maximum. If the bucket does not move, no work will be done, though force will be exerted.

Bucket Speed Required

UNDER the conditions given for the expansion of the 1 lb. of steam, the bucket should theoretically move at a velocity of 2020 ft. a second to get the best results, which for a wheel 3 ft. diameter would mean a speed of 12,850 r.p.m. Since the jet cannot move tangential to the wheel (the best angle in practice being found at 20 deg.) and as the velocity when leaving the nozzle is only 97 per cent of the theoretical, also because of frictional resistance and other modifications, it is found that the best speed for the bucket is 1960 ft. a second. Even this is found to be greater than the safe strength of the material used for wheels will bear and the speed actually used for the conditions named is 1400 ft. a second. This allows a use of about 73 per cent of the energy of the expanding steam but still calls for a speed of 9520 r.p.m. in the 3-ft. wheel.

Methods adopted for overcoming the difficulty thus encountered are, geared reduction of speed; staging, that is expanding the steam in steps so as to reduce the velocity when it leaves the nozzle; and use of reaction buckets for fractional extraction of the energy, that is, taking only part of the energy of the jet of steam out in one row of buckets, and then passing the steam to another row of buckets for taking out another fraction of the energy. The use of very large wheels to get added bucket speed has not proved satisfactory on account of the mechanical problems in making the wheel and the friction from windage and skin friction on the large surface of the wheel body.

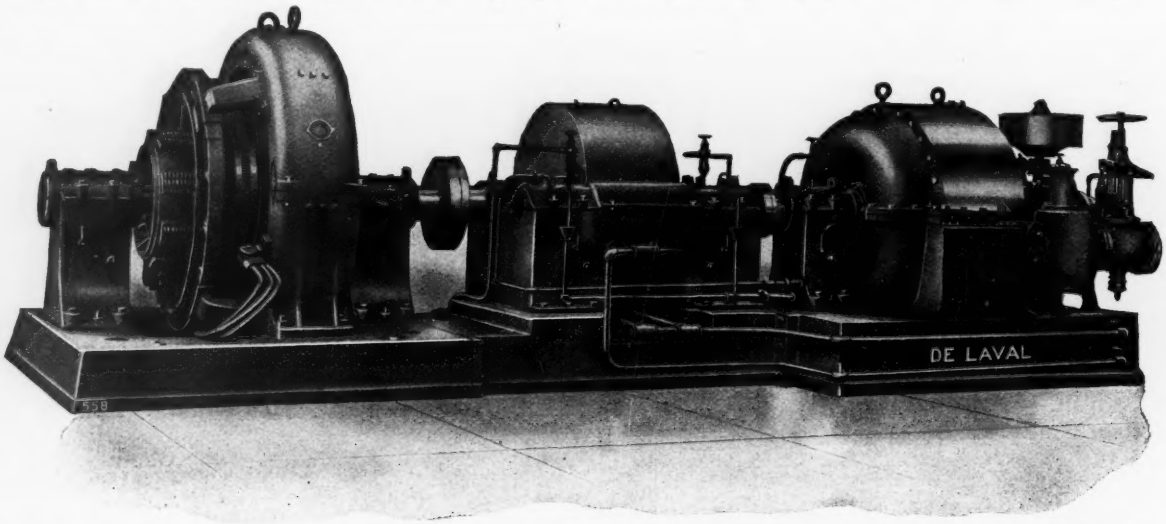


FIG. 1. DE LAVAL MULTISTAGE GEARED TURBINE DRIVING CROCKER-WHEELER STANDARD GENERATOR OF 500 KW.

Gearing was adopted by DeLaval over 30 yr. ago and has proved satisfactory in sizes up to 750 hp., making possible the direct connection of all kinds of machinery to the turbine unit and the driving of other machinery by belts and ropes.

Methods of Staging

STAGING is done in 3 ways; first by setting a wheel so that it travels at say ⅛ the speed of the jet instead of ½ and then reversing the jet after its passage of the first wheel and sending it through another wheel to take out more of the energy, and so on, each row of buckets taking out ¼ the energy of the jet. It is found, however, that 2 rows of buckets are all that can be used to advantage, for the friction and loss in

the buckets runs the jet velocity down to the point where the work from the extra rows of buckets is too small to pay for the complication and cost of the machine.

The second method of staging is the use of pressure stages, the total range of pressure being divided up into parts and the expansion of each step or part being taken care of by a set of nozzles and buckets. This gives a series of separate turbines, each operating through a small pressure range and all mounted on the same shaft. But, as velocity of jet varies as the square root of the pressure range, dividing the pressure range into 4 parts will reduce the velocity only half, so that the problem of wheel speed is still troublesome. To reduce the wheel speed to ¼ that for a full expansion turbine would involve the use of 16 stages instead of 4. That means great complication and cost of construction as well as losses from friction of the shafting in the bearings and the wheels in the steam.

Reaction Method

IN the reaction turbine the expansion takes place partly in the buckets and partly in the guide vanes, the force on the buckets being almost entirely from the expansive reaction. The buckets should move with the velocity of the spouting steam since no energy is to be taken out by the impulse of the jet on the bucket. In order to get a reduction of the wheel speed to ¼ that of the simple wheel first discussed, as has been done in the other methods, it will be necessary to get a jet velocity for each row of buckets ⅛ that of the jet for full expansion.

The spouting velocity of the jet varies as the square root of the energy drop, hence the energy and pressure drop would have to be divided into 64 stages in order to get the wheel velocity reduced to ¼ that of the single wheel. But as there is a drop in the guide blades as well as in the wheel, there need be only 32 rows of blades to give 64 stages of pressure drop.

Multistaging by pressures or velocities, or the reaction system, involves a chance for loss by leakage of steam past the bucket ends or shaft, but this can be reduced by careful design and construction so that it is of little practical consequence.

Comparison of Types

TO compare the types of wheels an example is the best method. Suppose that the problem is to obtain a driving speed of 600 r.p.m. from steam at 150 lb. gage, exhausting to a 28-in. vacuum; that the admission angles are 20 deg. throughout and that the blade coefficient is 100 per cent. The single wheel turbine will be 62 ft. in diameter. If a 3-ft. wheel is used with gear reduction, a gear ratio of 21 to 1 will be required. If velocity stages are used on a 3-ft. wheel there must be 21 of them. If they are divided into 2 groups with pressure drop between, each will need to contain 14 velocity stages. If they are divided into 3 groups of pressure stages, each will need to contain 14 velocity stages. The multicellular turbine, with pressure stages throughout, will, neglecting the fact that the friction loss in one stage is available as heat for the next stage, contain 440 stages. The reaction turbine will contain 1760 stages, that is, 880 rows of moving buckets.

The single-stage wheel, without gears, may be thrown out of the discussion because of its size and the difficulty of construction. The single-stage geared wheel is entirely suitable in sizes up to about 750 horsepower, as stated, but in sizes above that it will be found that, unless the blades are made quite long or unless the angle of entrance is increased, the power of the wheel is strictly limited by the available area for the nozzle outlets. At the outlets these nozzles must have an area corresponding to the final volume of the steam expanded down to 28 in. vacuum. If the nozzle area is increased by increasing the length of the blades, the latter soon reach their limit of strength at the root for the speed employed, and, as a third limitation at high powers, the speed of the shaft in its bearings would be excessive, considering the thrust which they would be called upon to withstand in transmitting the power to the gear, although this one objection may be obviated by the use of double gears, wherein the downward thrust of one upon the pinion is balanced by the upward thrust of the other, so that, little if any, pinion thrust is transmitted to the bearings.

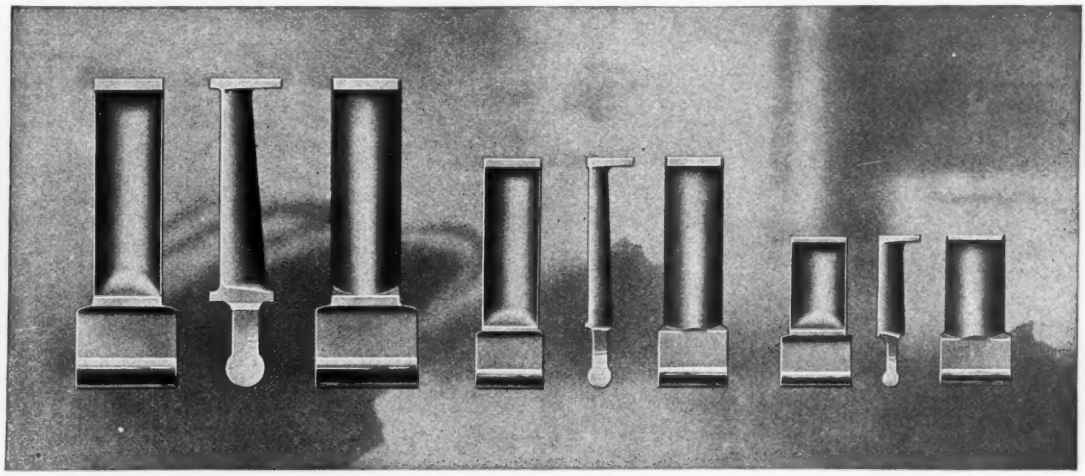


FIG. 2. DROP-FORGED BUCKETS USED IN DE LAVAL WHEELS

In the multistage turbines of any type, the requirements are impossible for the speed mentioned, as the length of shaft required would be mechanically too weak to stand the strain imposed by the wheels. For this reason the apparatus has been designed to work at the faster speed demanded by the turbine conditions, as in the case of alternating-current generators and special designs for direct current. These speeds involve, of course, in electrical machinery, difficulties of design and operation which have been met, to be sure,

but which have given, nevertheless, considerable trouble. It is the opinion of a great number of designers that the speed of direct-current generators of 1000 kw. and over should not be over 600 r.p.m., and even down to 500 kw. it is better that the speed does not rise above that figure.

DeLaval Multistage Geared Turbine

HELICAL reduction gears were adopted by DeLaval almost at the inception of his work on the steam turbine and have proved entirely satisfactory under service conditions, while having many advantages over the other methods of speed reduction. There is a general and natural objection to the introduction of gears where their use can be avoided, but, if by special design and methods of construction gears can be made at a reasonable expense that will be reliable, efficient and long-lived, while eliminating the several undesirable features inseparable from a great number of stages, their use becomes the logical engineering procedure. The efficiency of the double helical gear as

FIG. 3. DIAPHRAM AND GUIDE PLATES

made by the DeLaval companies has been found to lie between 98.5 and 99 per cent, while the life of the gears is equal or superior to the wearing parts of other steam machinery.

The fact, however, that the capacity of the single stage turbine is limited, as pointed out in a preceding paragraph, has led to the assumption on the part of many that the limitation lies in the gear. This is not the case, and over 5 yr. ago the DeLaval Co. of Sweden instituted experiments with a view to the development of a high-power single-gear reduction and about the same time offered to install a 550-hp. gear for driving the steamer Atland by steam turbines.

Experimental work was nevertheless continued on large gears for stationary turbines, including not only the gear itself, but also suitable machinery for the accurate production of the gears. The need of special effort in this direction is shown by the fact that several months of continuous work by a skilled machinist were required for the correction of a lead screw purchased from one of the best shops in this country, before it was considered sufficiently accurate to be used to produce the gears for the turbine set.

General Arrangement

THIS generating unit, shown in Fig. 1, consists of a multi-stage turbine driving a standard-speed direct-current Crocker-Wheeler generator through a pinion and single gear, the speed of the turbine shaft being 3600 r.p.m. and the speed of the generator shaft 500 r.p.m. The maximum capacity of the turbine is 1200 hp.

The main casing consists of cast iron and is approximately cylindrical in shape, being split horizontally so that the top half may be lifted off to give access to the revolving and stationary members of the turbine. The casing is supported on a level with the center of the shaft by 2 pedestals rising from the bed plate, one on each side, and is bolted down only at one end, being free to expand and contract in an axial direction between steel guides. As the endwise position of the shaft is also determined by a thrust bearing the same end, the results of axial expansion are largely compensated for.

Steam Wheels

STEAM is admitted to the turbine first through a strainer case and then through a combined trip and throttle valve, to be seen at the extreme right; next through the adjacent governor valve and then, after passing through steam nozzles of the standard DeLaval type, impinges upon the blades of the first-stage wheel. Partial admission is used in the first stage, but full admission in later stages. The wheels are of the standard DeLaval type, made of such section as to give great strength throughout.

Buckets are set in the rim by a peculiar form of dovetail, as illustrated in Fig. 2. The buckets are drop forged from solid bars of noncorrodible metal and are allowed to retain the original smooth, glossy finish imparted by the drop-forging process. Such buckets, it is found, wear much more satisfactorily than machined buckets, since they present a smoother surface initially, and if they receive only dry steam their life is almost unlimited. The use of a special metal also avoids rusting.

Wheels are mounted upon the shaft by split taper sleeves drawn tightly into place by internal nuts in the wheels, and after the wheels are assembled, a lock nut on the shaft serves further to secure them, while rotation of the wheels about the shaft is prevented by a key. The greater blade length required by the increased volume of the steam as it proceeds towards the exhaust is secured both by reducing somewhat the diameters of the wheel bodies and by increasing slightly the bore of the casing.

Guide Blades and Packings

UPON rebounding from the moving blades the steam again expands by passing between the guide vanes placed all around the periphery of the diaphram between the first stage and the second stage. These blades are made of "extruded" metal and are fitted onto the cast-iron diaphram. The diaphram itself is slightly dished in order to increase its strength to withstand pressure and to complete it, a solid steel band is shrunk over the tips of the guide blades, see Fig. 3. The steel band is slightly wider than the blades and diaphram and as adjacent bands touch

each other, a complete steel casing is formed which would effectually prevent the possible penetration of parts in case of rupture of the wheels. The center of the diaphram is perforated for the passage of the shaft and leakage of steam is prevented by a labyrinth packing.

Packings surrounding the shaft at the high-pressure and low-pressure ends are more elaborate. The high-pressure packing, which is called upon to withstand a pressure of about 25 lb. gage, consists of a long labyrinth, followed by 4 carbon packing rings. Any steam leaking by the labyrinth packing is piped to one of the intermediate stages of the turbine and utilized, while any steam leaking by the first carbon ring is taken to the exhaust outlet. The packing at the exhaust end of the turbine consists of 3 carbon rings, steam at reduced pressure being led in between the first and second rings from the outside, which is also done at the high-pressure end. This insures that any leakage into the exhaust when vacuum is carried, will be of steam, not of air.

Governing

THE governing mechanism, Fig. 5, is in duplicate, that is, there is a speed regulating governor and a speed limiting or emergency governor. The former is mounted at the top of a vertical shaft (near the right-hand end of Fig. 1) driven by a worm gear from the turbine shaft. It is extra heavy, and controls, through a system of 2 bell-crank levers and a connecting rod, the movement of a vertical double-seated poppet valve similar to that used on standard DeLaval turbines. In order to prevent damage to the valve by overtravel of the governor, a spring is inserted in the connecting rod, as seen in Fig. 5. The same worm which meshes with the worm wheel on the governor shaft, meshes with another worm wheel driving the tachometer, which is supplied as a permanent and regular part of the equipment. The lower end of the governor shaft is connected to the oil pump, supplying the bearings of the machine and the pinion and gear.

The emergency governor is located in the end of the turbine shaft itself and is ordinarily not in contact with the trip. Upon touching the latter, steam pressure is at once released from underneath a piston, by means of which a toggle gear is released, allowing the combined trip and throttle valve to close under the pressure of the steam in the supply pipe. This trip may also be sprung by hand, if desired, while the valve spindle is also furnished with a hand wheel and is threaded, so that it may be used as a throttle valve independently of the trip.

Reduction Gearing

PINION and gear, perhaps the most important and interesting part of the construction, are shown in Fig. 4. As will be noticed, the gear is of the double helical or herring-bone type, differing from the standard gears supplied with DeLaval turbines only in size and the fact that but a single gear is used for the largest capacities. The pinion is cut from a solid bar of steel and is carried in plain babbitted bearings supported in a rigid cast-iron frame, which also supports the gear bearings. The pinion bearings are lubricated by sight-feed oilers from the pump system before referred to, the excess oil overflowing to the wells of the gear bearings, which are ring oiled. The gear consists of a solid cast-iron center upon which are shrunk 2 thick steel rings. The hub is mounted on a stiff shaft, which carries at one end a half of the flexible coupling for connection to the driven machine.

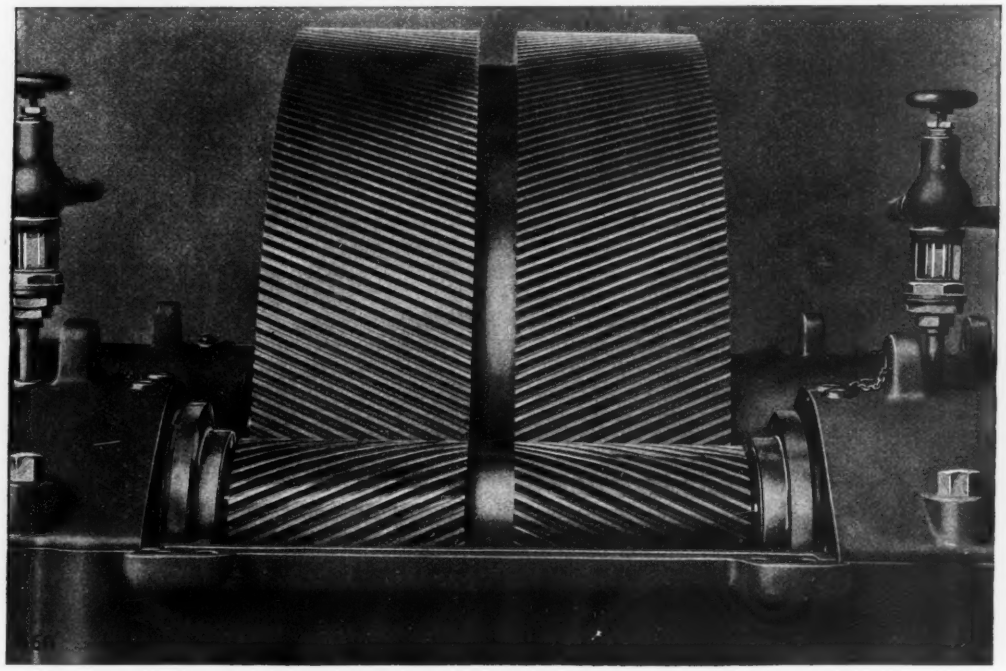


FIG. 4. GEAR AND PINION FOR DE LAVAL MULTISTAGE TURBINE

Lubrication of the gear and pinion teeth is accomplished by jets of oil directed at the line of contact on the entering side. This oil after use is passed through an oil strainer located in the base of the turbine, then through a cooling and settling chamber and then to the oil well, from which it is again pumped through the circuit.

Operation of the turbo-generator above described is remarkably free from vibration and noise and as it stands in the test room, supported upon small screw jacks without other steadying means, it is impossible to tell from a few yards away whether or not the turbine is running without noting moving parts. There is no vibration and no noise that may be overheard at a short distance. The quiet running is attributed largely to a specially designed gear-cutting machine and the adequate method of lubrication employed.

Generator

THE generator is of the standard Crocker-Wheeler engine type adapted for the speed of 500 r.p.m., the same as used for a belted machine of this capacity. The field consists of 8 main poles and 8 auxiliary or commutating poles, the commutating poles being connected in series with the armature circuit and so proportioned as to eliminate sparking through all ranges of load.

Shunt field coils are of cotton-covered wire, thoroughly impregnated and insulated. The series field coils and interpole field coils are of solid copper bars, formed to shape and insulated thoroughly from the pole, pole shoe and shunt field coil by wooden and fiber spacing blocks. The armature coils are of strip copper, form wound and heavily insulated. They are retained in the slots by wedges and are held down on the heads by band wires. The great wearing depth of copper in the commutator is a feature which, in connection with the perfect commutation, makes for long life.

ONE EFFECT OF THE development of the steam turbine has been the increase in size of electric units for central stations. It is now possible to install generators of from 15,000 to 20,000 kw., which is more than double the size formerly possible.

INTERESTING TURBINE TESTS OF PACIFIC MILLS POWER PLANT

TURBO-GENERATORS installed in the power house of the Pacific Mills, Lawrence, Mass., by Charles T. Main, and described in Practical Engineer for December, 1908, have recently been tested by him.

In order to determine the economy of the units under test, each machine was isolated in turn from the rest of the station and fed from a separate battery of boilers, the load being supplied by a water rheostat. During the progress of each test the remainder of the station equipment of both boilers and turbines took care of the ordinary factory load.

Two of the 3 turbines in the station, known as Nos. 1 and 3, were tested. These machines are of the Parsons type as manufactured by the Allis-Chalmers Co. and rated at 750 kw. each. They operate at 1800 r.p.m. and are direct connected to alternating-current generators, 3-phase, 60-cycle, at 2300 volts. These generators are of the enclosed type and receive air for cooling the windings through a ventilating duct communicating with the outside of the building.

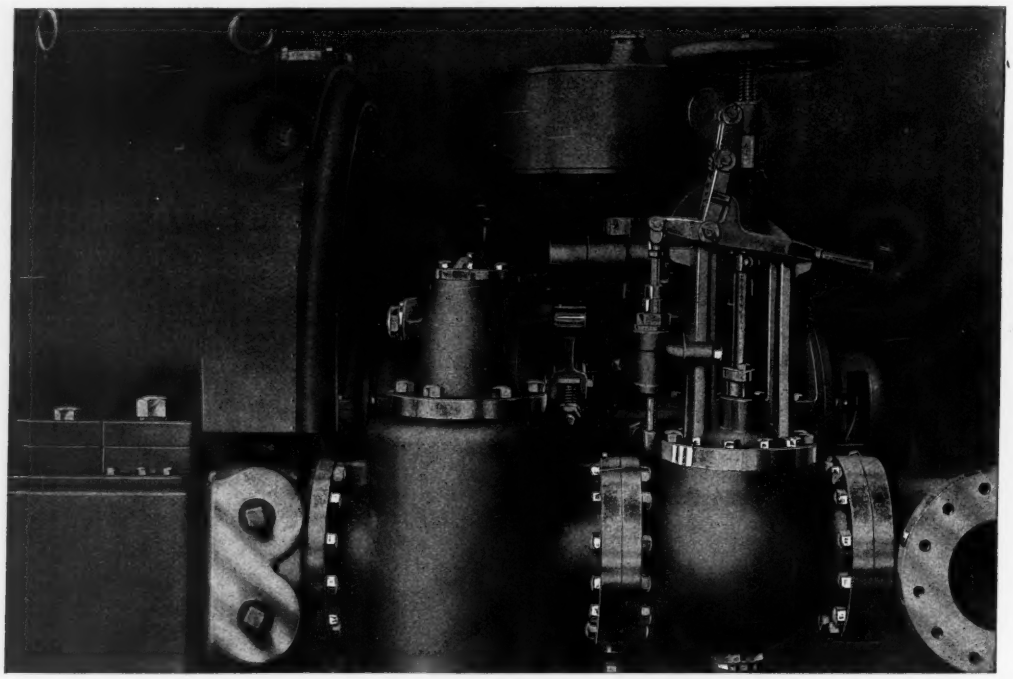


FIG. 5. GOVERNORS AND VALVE MECHANISM

Condensers and Steam Supply

TURBINE No. 1 is equipped with a jet condenser and a Warren steam double-acting condenser pump. Turbine No. 3 is connected with an Allis-Chalmers turbo-jet condenser equipped with a cycloidal pump. The boiler plant is so arranged that each battery may be isolated from the rest and fed independently from either of 2 sources of water supply. Thus, by manipulating the necessary valves it was possible to run any one turbine from one of these isolated batteries and to determine the amount of steam supplied to the turbine by measuring the feed

water to the boilers. The auxiliaries of the turbines under test were supplied with steam from other sources so that the only outlet for the steam from the isolated battery was through the turbine under test.

Tightness of System

PREVIOUS to starting each run, all piping and valves were inspected to guard against any leaks. Wherever possible, this inspection consisted of applying pressure to one side of a valve and opening the other side to the air. No leaks, however, were discovered except in the case of one blowoff and a small bypass, both of which were so small in amount that they might well have been neglected; but in order to insure the highest possible degree of accuracy, a correction was made for both these small leaks.

As an additional precaution, blanks were inserted in the feed-water pipes. All drips from the steam piping and boilers were shut off and one side of the blowoffs opened to the air for observation.

Water Measurement

FEED water was measured in 2 tanks holding about 2400 lb. each. These were accurately calibrated and provided with fixed hook gages which read 1/100 in. or to rather less than ½ lb. The arrangement was such that the water after being measured was allowed to flow by gravity into a third tank from which was taken the suction for the boiler feed pump. This suction tank was equipped with a fixed hook gage which was used in getting the water level at starting and stopping of each run, the level being brought to the same point in both cases, thus avoiding any possible error due to calibration of the tank.

Water level in the boiler gage glasses was marked at the beginning and end of each test and the water levels carefully brought back to these marks.. The vacuum was measured by a mercury column attached directly to the turbine exhaust nozzle. All gages and thermometers were calibrated before the beginning of the test.

Summary of Results of Turbine Tests

AVERAGE DURING TEST

Turbine Number	Load per cent	Load kw.	Steam Press. Lb.	Superheat Deg. F.	Correct Vacuum In.	Actual Water per kw.-hr. Lb.	Corrected Water per kw.-hr. Lb.
1	100	749.0	121.4	121.4	25.85	20.583	21.15
3	100	748.2	131.0	116.2	27.04	19.449	21.33
1	125	907.1	138.9	123.2	25.53	19.185	19.75
3	125	935.2	138.0	126.7	26.91	18.011	19.93
1	75	563.1	123.9	112.8	26.13	21.546	22.45

Note: The "corrected water per kw.-hour" is corrected for 150 lb. pressure, 125 deg. F. superheat and 27 in. vacuum. The power for excitation is not charged to the turbine.

Electrical Load

THE water rheostat used to absorb the generator output was located in the cistern under the turbine room basement. This rheostat consisted of flat plates held in a wooden frame and connected 3-phase star connection. The power readings were made on 2 wattmeters checked by ammeters and voltmeters. All the electrical readings were made by 2 observers independently and the results averaged. Constant excitation was furnished by a separate exciter.

Before the tests were started, all the electrical instruments were calibrated at the laboratories of the Massachusetts Institute of Technology, and after the completion of the tests, the instruments were calibrated in place by being connected in multiple with a set of instruments and transformers which had just been standardized by the Testing Laboratories of New York City. On all the runs the power factor was 100 per cent.

PEAT FUEL IN CANADA

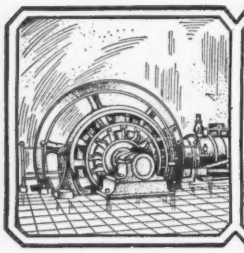
AS THE supply of coal becomes less and the mines go deeper so that the cost of mining increases, the attention of coal users naturally turns to other sources of fuel. One of the great resources is the peat bogs of the country in which a square mile within an average depth of 6 ft. will produce 774,400 tons of fuel, containing 25 per cent moisture. As showing the amount available, one bog in Canada has 12,000 sq. miles, estimated to contain 9,292,800,000 tons of peat, equivalent in fuel value to 5,306,000,000 tons of good coal, a supply, which according to the Canadian manufacturer would supply fuel to 5,306,000 families for 100 yr., allowing an annual fuel consumption to each family equivalent to 10 tons of anthracite coal.

In order to determine the possibilities of peat fuel for industrial use, the Department of Mines of Ottawa, Canada, has purchased some 300 acres of peat bog and has been experimenting with the peat system as used abroad. In this process peat is dug by hand and is transferred by an elevator into a pulping mill, the resulting pulp being conveyed by cable cars to the drying field, rolled into a sheet about 4 in. in thickness by a press, and is divided by knives into blocks which are dried on the field. The mill cars and field press are operated by steam engine, and the turning in the drying field is done by hand. Allowing 140 days for a season's operation, the cost of fuel on the field is figured at $1.40 a ton and when stored in the shed at $1.65 a ton.

In the Ekelund System, starting with air-dried machine peat with 40 to 50 per cent moisture, the peat is reduced to the form of powder with 10 per cent moisture, which is stated to be equivalent, pound for pound, to the best English bituminous coal. This peat powder is blown under a boiler and burns with a long, hot, smokeless flame, leaving no unburned particles. The cost of a ton of peat powder made from air dried peat, including power, wages, interest, depreciation, and so forth, is in Sweden $2.30 a ton, and the cost of the plant for the manufacture of 20,000 tons annually is $86,000. The cost in this country, however, would be higher, as common labor in Sweden gets a wage of but $1 to $1.22 per day of 10 hr. The Ekelund System has the advantage that the air dried peat harvested during the summer may be worked up into peat powder during the winter months.

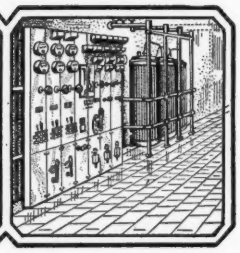
Eugene Haanel, director of the Department of Mines, concludes as an analysis of the method that the proper way to use the powder or any other fuel is by working it through a gas producer. He concludes also that in order to make the peat fuel industry satisfactory, a 20-hr. day, working 2 shifts must be adopted, as the profitable season for working a Canadian bog is not over 110 working days a year, and the most must be made of this short period in operating the machinery and transporting the peat to sheds.

THE KITCHEN AT West Point has been thoroughly electrified. The food is cleaned and prepared by electricity. Electric heat cooks and bakes the meats, vegetables and pastry. Electric power does the work of cleaning the dishes, sharpening the knives and polishing the silver.—Gas Power.



Electrical Machinery

For Generating, Transmitting and Using Current



DIRECT AND ALTERNATING CURRENT COMPARED

TO SECURE the highest efficiency, together with the most satisfactory service, for the least outlay of capital in the distribution of power by means of electric circuits, is the problem almost every engineer has to solve, and perhaps the first step toward this result is the selection of the proper system to be employed.

Distribution by means of direct current may be divided into 3 systems, these being the 2-wire, either with low or high voltage, 3-wire, and multiple-wire. The 2-wire system using low voltage is considered the safest and most simple, but the expense for copper is frequently prohibitive. The same arrangement, using high voltage, is much more economical and just as simple, but danger to operators and difficulty in building suitable machinery are factors which must be considered in many plants.

Advantages to be gained by use of the 3-wire and multiple-wire system are the same, that is, low voltage on the machine and saving in copper. Comparing the weights of copper required in these systems with the 2-wire circuits we get the following values:

Ordinary 2-wire system	1.
Three-wire system, all 3 wires of the same size	0.375
Three-wire system, neutral ½ size	0.313
Four-wire system, all 4 wires of the same size	0.222
Five-wire system, all 5 wires of same size	0.156
Five-wire system, 3 inside wires ½ size	0.109
Seven-wire system, all 7 wires of same size	0.097

There is a great disadvantage in 3-wire circuits due to the complication of the wiring system; the voltage between the main wires is twice that on a 2-wire system and insulation to take care of this increase must be made heavier; in order to secure best operation it is necessary to keep the system balanced and this requires considerable study and planning on the part of the engineer.

In many plants the neutral wire is grounded and there has been a diversity of opinions as to the advisability of doing this. For many years fire underwriters condemned this practice but at present it is adopted extensively. It is claimed that by grounding the neutral safety to the operator, in bringing the voltage down to half that between the main wires, is secured and also the ground return of the neutral will cut down the loss in this wire. This latter, however, in a balanced circuit is of little consequence as the wire will carry no current back to the generator. The 3-wire and multiple-wire circuits are applicable to either direct or single-phase alternating-current systems.

In the distribution of alternating current 3 general systems are employed: single-phase, multiphase and motor-generator. In all of these economy of copper for transmission is the principal advantage. For operating motors as the principal load, single-phase is seldom used, as the efficiency of the machinery is comparatively low and the motors must be started from an outside source or without load. Power circuits for mixed power and light systems, where the distance from the power house is considerable, are invariably 2 or 3-phase, which are economical in copper, will start motors under load, and do not require motors to run at synchronous speed.

The principal recommendation for the use of a motor-generator in an alternating-current system is to secure high-voltage transmission by alternating current, and low-voltage direct-current delivered. This system is expensive, however, and the total efficiency is low.

For short distances and indoor transmission direct current electricity is particularly adapted, but it does not readily permit changes in voltage, the lines can be run in any type of conduit or exposed system without loss of power, it does not affect materially other electric systems, but in case of a grounded return may cause electrolysis of gas and water pipes to a degree which may bar its use.

On the other hand alternating current is adapted for long distance transmission and cases where different voltages are necessary from the same circuit. For power purpose, 2 and 3-phase currents are employed and the circuits are apt to become complicated, care must be exercised when alternating current circuits are run in iron conduits to provide against inductance loss, and the proximity to telephone circuits is liable to cause the telephone to buzz and hum to a detrimental degree. Greater line loss and less efficient apparatus for equal voltages and the same size wire are usually experienced with alternating current.

Lighting

PRACTICALLY the only reason for using alternating current on lamps is the saving in copper. In the office districts of large cities many central station companies are obliged to convert alternating into direct current in order to hold their customers. The cause for objection is the tiring effect upon the eyes of the pulsating light which is the result of alternating current of moderate or low frequency.

Where lighting alone is the load of the station, the frequency commonly employed is 120 cycles per second, since this gives a better light, and the cost of transformers is less than where a lower frequency is used. For mixed power and lighting load 60 cycles is the prevailing frequency in this country, because of lower losses in motors.

The minimum frequency at which arc lights can be run is 40 cycles, and incandescent 25, and at these fre-

quencies pulsations can almost be perceived by the eye, and are therefore exceedingly tiresome. Arc lamps being used principally for street lighting can be run on alternating-current circuits with little disadvantage.

Motor Load

CHOICE between alternating and direct current for driving motors depends largely upon local conditions. While direct current at low voltage cannot be transmitted economically over distances above 1500 ft., by increasing the voltage the distance can be increased, but the ordinary limit of voltage for direct-current circuits is about 500, and the limit of distance in this case is about 8000 ft. For longer distances of transmission it is advisable to resort to alternating current, the voltage of which can be raised by transformers as high as need be to keep the line loss within reasonable limits. The operation of motors on direct and alternating current is equally satisfactory if the proper type of motor is used for the class of work to be done.

Comparing motors using direct and alternating current it may be stated that the series wound direct-current and the slip ring induction motor with external resistance for alternating current perform similar service, that is, will start under a heavy load with low speed at start and the speed varies with the load. Where a slight starting torque is necessary and a steady speed desirable the shunt wound direct-current or the squirrel-cage induction motor for alternating current perform good service.

To secure a constant speed under varying conditions of load with alternating current, the synchronous motor is employed. This, however, requires a means of starting it from an outside source, and cannot always be used where otherwise advisable. On direct current where the load is variable and a constant speed desirable, the compound wound motor answers the purpose.

Where necessary to control the speed a single-phase commutator type alternating-current or a shunt wound direct-current motor perform very satisfactory service.

Charging Storage Batteries

IN this work direct current is the only system that will serve the purpose, but there are a number of rectifying devices on the market which can be employed where only alternating current is available. When the load of the plant is largely storage battery or where storage batteries are used to carry the plant over a peak load, direct current is the only system that can be employed to advantage.

From what has been said it would appear that in nearly all cases the use of alternating current is resorted to in order to reduce line losses, for there are but few cases where direct current will not perform the work of the plant as well as, and in many cases better, than alternating current. As transmission loss and cost of copper are big items of expense in the power plant, the growth in the use of alternating current has been rapid in recent years, due largely to improvement in the design and operation of alternating-current machinery and appliances in which such current is utilized.

IT TAKES A GOOD deal of boldness, mixed with a vast deal of caution to acquire a great fortune; and then it takes ten times as much wit to keep it after you have got it as it took to make it.—Mayer A. Rothschild.

6600-VOLT DISTRIBUTING TRANSFORMERS

USE of voltages as high as 7500 volts for distributing systems has led to the standardization, on the part of manufacturers, of distributing transformers to meet these voltages. The converse of this is also true, that the ability of manufacturers to produce satisfactory distributing transformers for comparatively high voltages has enabled operating companies to adopt these voltages for distribution, thereby obtaining the line economies of high tension systems. For use on lighting and power service at voltages of 3800 to 7500, the Westinghouse Electric & Mfg. Co., of Pittsburg, has introduced the line of type SK transformers which supplement its line of type S lower voltage apparatus. These transformers in common with the type S are designed with

FIG. 1. WESTINGHOUSE TYPE S K 6600-VOLT TRANSFORMER

a view to high efficiency, plain, substantial mechanical construction and good regulation.

The appearance of a complete transformer is shown in Fig. 1. The cases, except of the large sizes, are of cast iron, of a regular shape. The cast-iron cover is fitted with an impregnated felt gasket which forms an air-tight joint and prevents the entrance of moisture. The leads are sealed where they issue from the case, for the same purpose. The nuts for the cover bolts are held in pockets so that they do not drop off when the bolts are removed. Lifting lugs are provided on each case for attaching hanger irons, and oil drains to draw off the oil; also a small hole at the bottom fitted with a pipe plug to determine whether any water is present. Cases of transformers of capacity larger than 15 kv.a. are corrugated to secure good radiating surface.

Type SK transformers are of the core type construction, as shown in Fig. 2, as high voltage dis-

tributing transformers can be built of higher efficiency in this type. The core is built up of specially prepared sheet steel punchings assembled in a cruciform cross section and forming a rectangular magnetic circuit. Joints between the laminations are located at points of maximum cross-sectional area to make the exciting current a minimum.

The coils are placed on the 2 legs of the rectangular core. Each coil is form wound and thoroughly insulated. The winding consists of rectangular copper conductor wherever possible, as this gives greater cross-section of metal for a given winding space than round wire. Generously proportioned air ducts are provided, through which the oil circulates freely and maintains uniform temperature.

The insulating materials used are prepared especially for use in the transformers. The coils are impregnated with a special compound impervious to oil and water, after being thoroughly baked to expel all moisture.

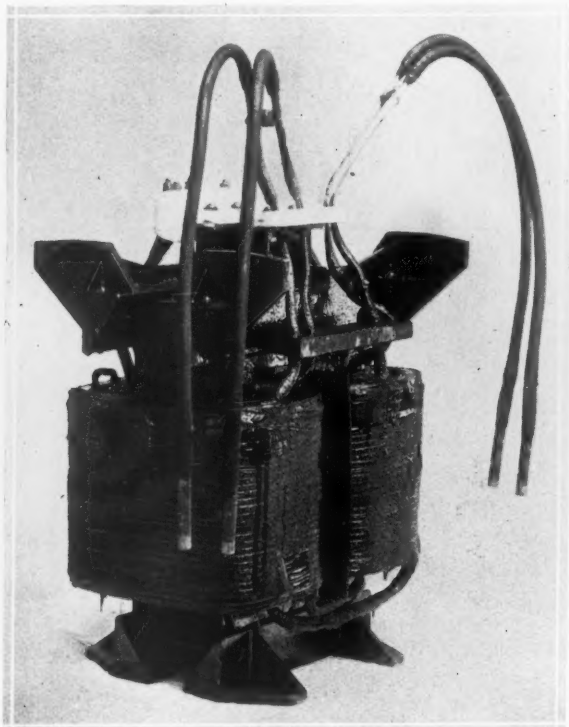


FIG. 2. TYPE S K TRANSFORMER WITH CASE REMOVED

As shown in Fig. 3, the high tension and low tension terminal blocks are separate. Both are of porcelain and for additional insulation are submerged in oil. The type SK was the first of the modern distributing transformers to have the terminal blocks submerged in oil, and there is a distinct advantage of such a practice for transformers for these voltages and above. The insulation on the ends of the leads that pass through the case ends above the oil level, to prevent siphoning of the oil out of the case.

The core punchings are held together by means of 4 cast-iron end frames, 2 on each side. The bottom frames have feet which support the transformer and the top frames carry the porcelain terminal blades.

The transformers are held in the cases by means of 2 pressure bolts equipped with wedges at each end, bearing against inclined lugs cast on the inner side of the case. A nut on each bolt forces these wedges against the inclined lugs and the top end frames and thus holds the transformer securely but permits easy removal.

The low copper loss in the type SK transformers results in good regulation, which is an important feature in distributing transformers. In addition the core losses are low and the efficiency is therefore high. It is pointed out by the manufacturer that the saving from the reduction in losses often more than offsets a larger first cost, and freedom from operating troubles always does.

IDEAL STARTERS FOR INDUCTION MOTORS

RAPID growth of alternating current systems of distribution enables such a wide application of induction motors that the development of a satisfactory starting device is of interest to all operators in the industrial and manufacturing field. This is particularly true in the case of squirrel-cage induction motors, which are generally recognized as the best electric drive for machines operating at uniform speed.

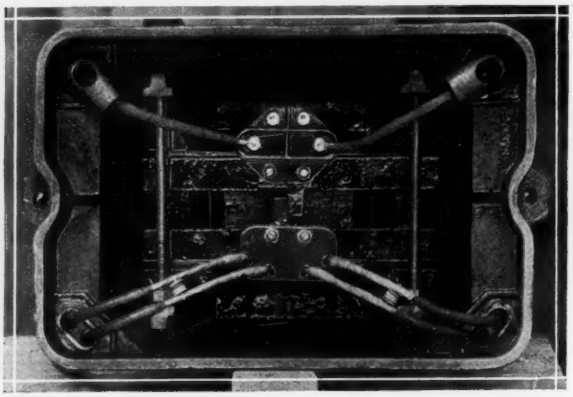


FIG. 3. TERMINAL BLOCK ARRANGEMENT OF TYPE S K TRANSFORMER

In order to use this type of motor to the greatest advantage, however, and to permit the application of the larger sizes on mixed lighting and power circuits, it is necessary to employ a starting device, which will reduce to a minimum the current taken from the line by the motor at starting. Otherwise the resulting voltage variations would be of sufficient magnitude to impair the proper regulation on such circuits.

Since the design of the squirrel-cage motor is such that a reduced starting current can be obtained only by impressing a diminished voltage on the motor terminals, it is clear that either resistances, reactances or compensators may be employed for starters. Motor operators long have recognized, however, that resistances and reactances are not only inadequate for obviating objectionable line disturbances, but fail to reduce the current taken from the line below the amount actually required for starting the motor. Therefore, great effort has been exerted to develop a starting device, which, while embodying a more effective electrical principle, is also susceptible of comparatively simple arrangement for automatically protect-

ing the motor against overloads and exposure to voltage failure, and for compelling the operator to start the motor properly, regardless of the amount of his experience in such matters.

The thoroughness with which these qualifications may be obtained by correct design and careful construction is shown in the improved hand-operated starting compensators recently placed on the market by the General Electric Co.

These compensators consist of an inductive winding with sub-voltage taps, and a switch for connecting the taps to the motor. They are of the single-step type, that is, the motor is thrown directly from the starting tap onto the line, but several taps are provided for giving a number of reduced voltages, any one of which may be selected, by trial, as suitable for the requirements of a particular case, and then subsequently applied at all times by permanently connecting the corresponding tap to the switch.

In operation these compensators permit the application of a reduced voltage to start the motor and bring it up to speed, the starting current being one-half the amount taken by the motor through a resistance or a reactance, at an equivalent reduced voltage, or one-quarter the amount the motor would take if it were thrown directly on the line. Consequently, by employing compensators of suitable capacity it is entirely practicable to use the largest size of motors on mixed lighting and power circuits without creating line disturbances of sufficient magnitude to interfere with the proper operation of the lamps.

In order to prevent any possibility of the motor being thrown on the line through the ignorance or negligence of the operator, the off position of the switch is located midway between the starting and running positions and an automatic latch is provided for holding the operating handle in the off position, thereby preventing the operator from throwing it forward into the running position, without first throwing it into the starting position.

The automatic protection provided comprises a system of spring-actuated release levers attached to the switch shaft, and an equipment of no-voltage and overload relays, which operate in conjunction with each other and with the hand operated mechanism.

The motion of the operating handle either towards the starting or the running position is always opposed to the tension of the spring actuating the release levers; consequently, if the handle is accidentally left on the starting position, the contractile action of the spring returns it at once to the off position, where it is engaged and held by the automatic latch.

The no-voltage and overload relays operate to produce a similar result. In case of voltage failure, with the switch in the running position, the no-voltage relays acts to free the release levers and allows the spring immediately to return the switch to the off position, thus disconnecting both the motor and the compensator from the supply circuit, and protecting them from the returning full line voltage.

The overload relays are inserted in the running circuit. They are designed to remain unaffected by the usual rush of current at starting, but can be adjusted to operate at a slight rise above the normal current, and thus open the no-voltage relay circuit, whereupon the switch will be snapped back to the off position by the action of the spring.

The action of the hand lever under the control of the automatic latch, compelling the operator to follow a prescribed mode of operation in starting the motor and allowing it to come up to full speed, before throwing it onto the running position and thereby connecting it to the full line voltage at the proper instant, cannot be duplicated by any device in which the entire switching operation is accomplished by a single sweep of the handle in one direction. This feature which insures the proper starting of the motor under all conditions and by any person either experienced or non-experienced, combined with the absolute reliability of the protective devices, render these starting compensators practically ideal in their line.

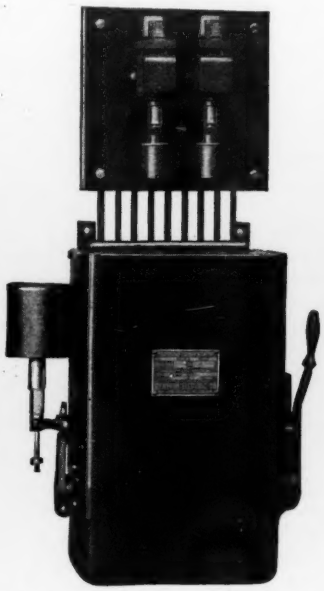


FIG. 1. EXTERIOR VIEW OF STARTING COMPENSATOR WITH NO VOLTAGE AND OVERLOAD RELEASE

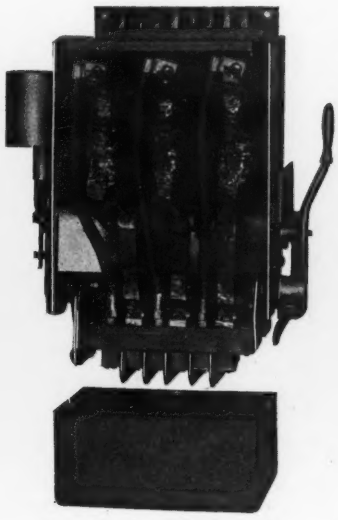


FIG. 2. INTERIOR OF STARTING COMPENSATOR

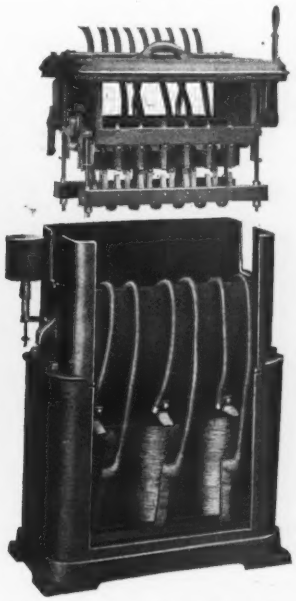


FIG. 3. TYPE C R FORM P STARTING COMPENSATOR FOR 250 HP. 2200-VOLT MOTOR

OPERATION OF ABSORPTION MACHINES

By Wm. Kavanagh

USUALLY the aqua ammonia is carried high enough in the generator to cover the steam coils. In practice it will be found satisfactory if the aqua is carried at about the middle of the glass. Should the aqua persist in falling below the indicated level it is a sign that more aqua is required.

The aqua comes in drums that are fitted with caps or plugs that are removable, a pipe connection is taken to the suction side of the rich liquor pump and this pipe is dropped down through the hole in the drum, the pump is started and while the pump is pulling out the aqua, care must be taken to prevent the pump from taking in air. This is done by having a measuring stick which is occasionally thrust down into the drum and noting the height of the remaining aqua. A valve is located near the drum on the suction pipe and when the aqua has fallen sufficiently

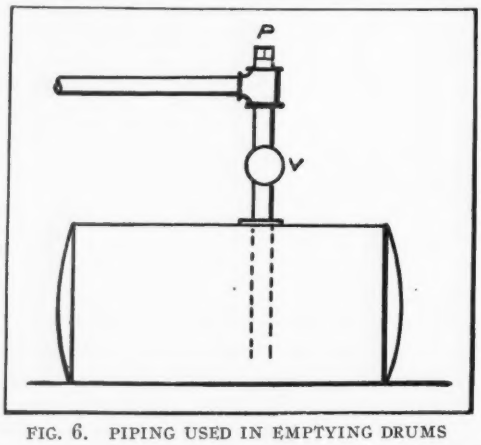


FIG. 6. PIPING USED IN EMPTYING DRUMS

low, so as to prevent considerable waste of the aqua the valve is closed when the pipe can be disconnected and the drum taken away. In some plants from 4 to 6 drums are necessary for a complete charge.

Before starting to pump out the aqua, it is a good plan to fill the pipe with distilled water. The plan of pumping out the drums is shown in Fig. 6. After the pipe is inserted in the drum, valve V is shut, plug P is removed and the water to fill the pipe is poured through the opening in the tee. When the pipe is filled plug P is screwed back and valve V opened when the pump can be started and the aqua pumped out.

When to Charge With Pure Ammonia

SOMETIMES the charge of aqua is poor in ammonia and it becomes necessary to charge the system with anhydrous ammonia, or gas. The condenser is fitted with a gage glass and when the anhydrous gas is liquified it rises in the glass showing its level. Gradually this level will lower and the difficulty in producing cold will increase and the gas pipe leading from the condenser or cooler to the absorber will not "frost" rapidly. These are indications that a charge of anhydrous gas will assist in maintaining the proper working conditions. Aside from the fact there may be plenty of aqua, and the coils for circulating the cooling water may be clean and the proper pressure may be on the generator, and the absorber and condenser will need no purging, then a charge of pure ammonia is what is needed.

The pure ammonia comes in cylinders the same as in the compression plant. Referring to Fig. 4, page 349 of the May issue, the cylinder of ammonia is shown at C and it is connected to the tee located between valves A and B. The high pressure side is shut off at A and the ammonia is discharged into the receiver L through B, then through the expansion valve E to cooler. The absorber being kept at its usual lower pressure. To facilitate charging in cold weather steam from a hose or pipe is played on the cylinder; this hurries the charge to enter the cooler. From 4 to 6 cylinders will be required in large plants.

Cleaning Coils

THERE are 2 or more sets of coils fitted within the absorber and condenser ranging from 1¼ to 1½ in. in diameter. Those coils are connected to a header and the water flowing in and out of each coil is controlled by a valve. In the cooler coils the water is controlled by cocks for quick action in case of a leak. When cleaning, the flanges are disconnected and a steam hose is attached to each coil in turn and blown out with high pressure steam.

If this does not clean the coils then fill them with a mixture of muriatic acid and water and allow them to stand over night or longer if necessary. The proportion of the mixture is 1 of acid to 3 of water. After the use of the acid, wash them out with clean water and connect back the flanges when the coils will be in shape for a season's run.

Dirty and Leaky Coils

WHEN coils are dirty, it will be found the water will flow very slowly through them and the temperature of the absorber and condenser will be hard to maintain at the right point.

Whenever a coil leaks it must be shut off until an opportune moment arrives for repairs. Should a coil leak in the condenser the ammonia will enter that particular coil because the excess pressure is on the ammonia side. The leaky coil can be discovered by connecting the drip of each coil separately so that it can be run into a pail or tank, when the leaky coil is found the water issuing from this drip will be milky in appearance. A test can be made with litmus paper if desired but usually the odor is a sufficient indication that the right coil has been found.

When a leaking coil is in the absorber the cooling water will flow into the liquor and weaken it. This can be known by an increase of aqua in the generator and also by the gravity of the liquor. In this case the liquor is pumped out of the absorber and the coils inspected by allowing the circulating water to flow through them when water will issue through the leak. The leaking coil can be cut out or repaired. In large plants, in order to prevent a shutdown from such unavoidable accidents, they are fitted with duplicate condensers and absorbers; this insures continuous operation.

Brine Circulation

IN the absorption system brine circulation is similar to brine circulation in the compression system. The brine is taken from the coils in the cooler by the brine circulating pump and discharged through the coils located in the various cooling rooms. The pressure under which the brine is circulated varies. At

the plant described here the brine is circulated under a pressure of 50 lb. and the temperature of the outgoing and incoming brine is regularly noted, the difference varying from 3 to 8 deg. Thermometers are inserted in the discharge and suction pipes for this purpose.

The brine is forced into the bottom of the coils and it flows out at the top to the main return pipe. The method of circulation is shown by the darts in Fig. 7, a tee shown at T is connected in the lowest pipe of each coil for the purpose of cleaning it out. The brine will circulate faster in the coils situated in the lower floors, but by choking down the valves on those coils a stronger circulation can be had on the upper floors. In this way an even temperature can be maintained in the different cooling rooms.

Dead Liquor

ACCUMULATION of dead liquor will occur in the cooler and it must be taken out. To take dead liquor from the cooler shown at C′ Fig. 1, page 347 of the May number, shut the gas valve G′ and also the poor

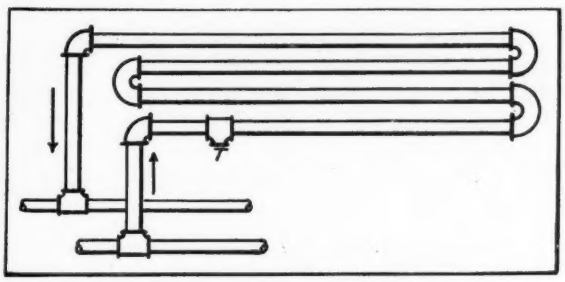


FIG. 7. BRINE COILS SHOWING CIRCULATION

liquor valve on the absorber, and pump a vacuum in the absorber. The gas expanding in the cooler will force the dead liquor over through pipe B when the dead liquor valve is opened on this line. The absorber and condenser are also fitted with purge valves as shown at H, H′ and I. Of course, when purging any of those tanks the precaution should be taken to immerse the hose or purge pipe in a pail of water, otherwise the odor of the gas will drive away the person doing the purging.

Starting the System

IN starting the system the generator is filled to the middle of the gage glass with aqua ammonia, a little steam is admitted to the heating coils in the generator to start a vapor which will be sufficient to expel the air from the system by compelling the vapor to flow towards the condenser, the purge valves or vents are left open until the air has been driven out. As soon as an odor of ammonia presents itself the purge valves can be shut and more steam turned on the generator coils which should be heated up slowly.

Gas will now be generated and flow to the condenser where it will be liquified, the cooling water being previously admitted to the coils, liquid ammonia will now be at the expansion valve E. This valve is now opened a small amount which will admit a small stream of the liquid to enter the cooler where it will be turned into a gas by reason of its heat absorbing power, or low boiling point. The gas will now flow through G′ into the absorber, the weak liquor now flows from the generator and a sufficient quantity of it is admitted to take up or absorb the incoming gas. As soon as the liquor has appeared in the absorber gage glass and has risen sufficiently high the rich liquor pump can be started to do its work by pumping back the rich liquor to the generator as explained before.

This conformity of operation is now maintained, it being only necessary to arrange the flow of cooling water to produce an even temperature all over the absorber and to chill off the water vapor in the rectifier. All of the cooling water should first pass through the condenser coils, but where water can be had free each coil can be supplied independently of the others. The exhaust steam from pumps, engines, etc., can be utilized in this system of refrigeration and where there is not sufficient exhaust steam live steam must be added to make up the amount necessary to produce the required pressure on the generator.

MIXTURE FOR AMMONIA JOINTS

THE best composition for making ammonia joints is a mixture of litharge and glycerine. Mix a small quantity of litharge with sufficient glycerine to make a thick paint or thin putty. Put this with a brush or the finger on the thread of the pipe and screw the pipe into the fitting just like a well made steam joint. Then smooth the remaining mixture on the outside of the pipe and let it set. Setting must take place within from 10 to 30 min. or the litharge is of no account or has been mixed too thin. Be sure that not a trace of oil is on either the pipe or the thread of the fitting else the mixture will not harden.

All threads should be carefully cleaned with gasolene before using the mixture of litharge and glycerine. A better mixture for this purpose is not known to the trade, but is must be made up only in such quantity as is needed right at the time as it cannot be used after it starts to set.

J. C. B. in Ice.

CORRECTION NOTE

Mr. Kavanagh calls attention to errors made in his article which appeared in the May number, as follows:

On page 348, under the heading "The Absorber," the article reads: "This is shown in Fig. 3, the gas enters the absorber through pipe P from the cooler and the poor liquor enters through spray valve V," etc. As a matter of fact, the poor liquor is generally sprayed upward to meet the incoming gas from the cooler, and not downwards, as may be easily inferred from the drawing. The gas enters through V and the poor liquor is sprayed upwards to meet the incoming gas. Also the gage glass on the absorber is nearly as long as the absorber is high, in the sketch the gage glass is only about one-third as high as the absorber.

J. B. EMBREY, secretary of the Practical Refrigerating Engineers' Association, with headquarters in Shreveport, La., reports that the growth of the association since its organization last December has been phenomenal and has far exceeded the most sanguine expectations. The association is composed of white refrigerating engineers of good moral character, who have had one or more years experience in operating ice and refrigerating plants, and is destined to fill an important niche in refrigerating engineering, in the near future. Many of the members even now are obtaining substantial aid from the association. The objects, scope and other information concerning the association may be obtained from the secretary, box 178, Shreveport, La.

EXPANSION IN STEAM PIPES

AS steam is turned on and off the piping system, the temperature will vary, the range running from the temperature of the atmosphere which may go as low as freezing to that of the steam, which if superheated will be as high as 500 to 600 deg. F. This heating and cooling will cause expansion and contraction which must be taken care of in the design of the system or it will cause trouble on account of the movement of the joints.

Before allowance can be made for the come and go, it is necessary to know the amount of the motion which will take place. This depends upon the length of the pipe run, the material of which the pipe is made, and the temperature range.

The amount that a piece of metal will expand in proportion to its length for 1 deg. rise in temperature is called the coefficient of expansion and the values for cast iron, wrought iron and brass are as given in the table accompanying. These values vary with the temperature, being larger at high temperature than at low.

There is also a direct relation between these coefficients for different materials. The wrought iron is 1.1 times the coefficient for cast iron and brass is 1.6 times the coefficient for cast iron. The rule for finding the amount of expansion in any pipe run is to multiply the coefficient of expansion at the given temperature by the length of the pipe in inches and by the number of degrees rise in temperature. This will give the expansion in inches.

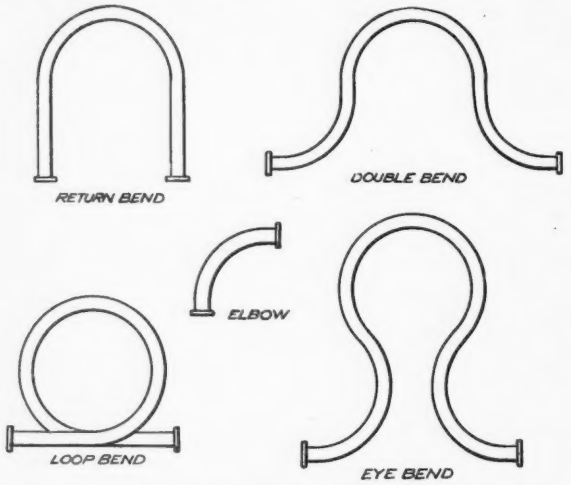


FIG. 2. STYLES OF EXPANSION BENDS FOR STEAM PIPE

In order to save the trouble of doing this, values have been computed and plotted in the form of curves, the method of establishing these curves being first suggested by W. L. Durand. The curves as plotted are given in Practical Tables Data Sheet, one of these being for wrought iron and steel pipe, for which the coefficient of expansion is practically the same, and the other for cast iron and brass, the figures at the top of the diagram being used for cast iron and those at the right hand for brass pipe. The values for brass pipe are not exactly accurate but are near enough for all practical purposes.

To show the use of these curves, suppose that a pipe run 75 ft. long is to carry steam at a pressure of 125 lb. and with 200 deg. superheat. At that pressure the temperature will be 353 deg. and 200 deg. superheat would make it 553 deg. Assuming the temperature of the air to average about 53 deg. would give the temperature rise as 500 deg. We start from the left-hand side of the diagram on the line corresponding to 75 ft. in length, go to the right to the intersection with the vertical line for 500 deg. rise.

We find that we are between the curves for 3½ and 3¾ in. expansion. It would be safe, therefore, to provide for 3¾ in. come and go, as the temperature range might vary a little more than figured.

Since the expansion is directly proportional to the length, if we wish to figure for a run more than 100 ft. in length, we can take the expansion for 100 ft. and multiply it by the number of hundreds feet in the run. For example, in a run of 245 ft. to carry steam at 300

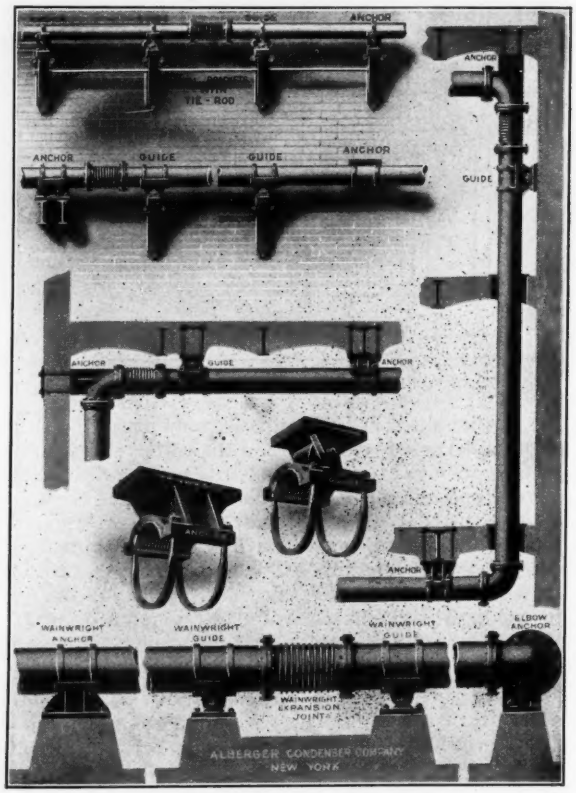


FIG. 4. DETAILS OF ANCHORS AND GUIDES AND METHODS OF INSTALLING EXPANSION JOINTS

deg., we note that the intersection of the 100 ft. horizontal and the 300 deg. vertical is about half way between 2½ and 2¾ in. expansion. Consider this as 2⅝, that is the expansion for 100 ft. This is to be multiplied, for 245 ft., by 2.45, which gives us 6.45 in. or approximately 6½ in. expansion to be taken care of.

Having determined the amount of expansion to be taken care of, the next question is, how shall this be arranged for so that the pipe may come and go what is necessary without injury to the joints? Where a very long line is to be taken care of it is usually best to divide the expansion between different sections, anchoring each section at its middle point. Expansion may then be taken care of by pipe bends, by

joints arranged to swing on the thread, by slip joints or by diaphragms. The slip joint consists of a stuffing box through which slides a finished end of pipe.

In the case of slip joints the amount of expansion which each joint will take care of is, of course, determined by the length of the slip tube. In the case of corrugated diaphragms or tubes the amount of movement is specified by the maker of the joint. A swivel will, of course, take care of any amount of movement but, if made up with pipe nipples and elbows, the movement should be limited because the joint will be loosened if this be excessive; also a large amount of movement will cause an angular swing in the pipe unless a double offset be taken to one side.

In using a bend the amount of elasticity in the bend is determined by its radius and by the size of the pipe of which it is composed. The amount of movement that may be taken care of in a 6-in. steel pipe by bends of 4 ft. from crown to crown are given by Stromeyer as follows: 2 straight pipes, 0.21 in.; a U bend continuous, 0.42 in.; an ogee either close or open, 0.74 in.; a complete circle, 0.74 in.; a circle perpendicular to the direction of the pipe line, 2.6 in.

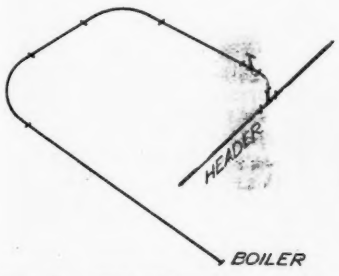


FIG. 1. EXPANSION BEND FOR CONNECTING BOILER LEADER

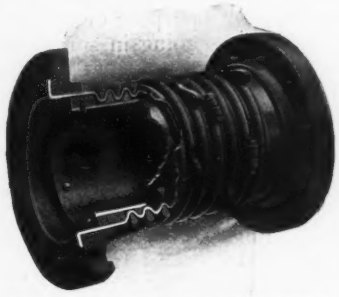


FIG. 3. WAINWRIGHT EXPANSION JOINT IN PART SECTION

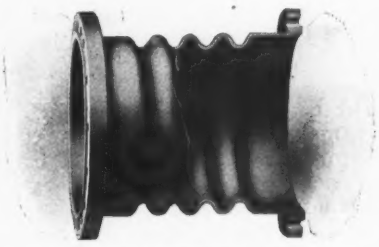


FIG. 5. WAINWRIGHT JOINT FOR LOW PRESSURE

These bends may be placed either horizontally or vertically, but the horizontal lie is preferable on account of the drainage of the piping. If the bends are placed vertical, provision for drip must be made at each side of the bend; if horizontal, the water will flow along the pipe the same as on a straight run. The shortest radius to which a bend should be made is not less than 6 diameters of the pipe for wrought iron and steel, and to get the proper spring for long runs the radius of curvature will be much larger than this. The trade names for the different styles of bend are the elbow, the return bend, which is the U form, the double bend, which is an open ogee, the eye bend or close ogee and the loop bend, which is a complete circle.

By stretching these bends somewhat in erection, a greater amount of motion may be taken care of, as, for instance, the 4-ft. double bend, eye bend and loop, if stretched 0.82 in. in erecting cold, would then allow a motion of 1.64 in. between the highest and lowest temperatures, enough to take care of a length of 50 ft. of main. The U or return bend and the elbow cannot, of course, be stretched in erection, as the joints will not then line up.

Placing the expansion bends in a horizontal position involves strain on the supports, as the spring of the expansion bend, unless it be of the complete loop type, will tend to throw the pipe slightly out of line. On the other hand, if the bends be placed in the vertical plane the tendency is to lift the pipe from the supports which involves no strain upon them. The choice between the 2 methods of placing the bends must lie with the engineer in charge of the installation and which is to be preferred depends on which of the 2 difficulties, drainage or side movement, can be more readily provided for.

In making up a bend compounded of curves and straight sections, the straight part between the curves should be at least 12 in. long. Care should be taken in making the bends that the seam be on the inside radius, as this will give less tendency to flatten and also less likelihood of opening the seam.

The spring of the pipe itself may take care of the expansion where sections of the pipe at right angles to each other, are of considerable length and free to come and go, but that this cannot be relied upon to any extent is shown by the fact that to take care of a 4 in. expansion in 4 in. pipe, would require the pipe coming up to the expanding run to be at 30 ft. long at 12,000 lb. fiber stress.

The method of taking care of some expansion is by introducing what is called cold strain, that is, cutting the pipe short and putting strain on the cross piping by means of the bolts when making up the joints. If the cold strain be made equal to the amount of the expansion the pipe will, when under pressure, be exactly the right length, but this is difficult of accomplishment and hardly advisable.

It is common in good practice to put cold strain on which will take care of half the expansion, that is, the length of pipe for a run is cut short by one-half the estimated amount of the expansion and this shortness is taken up by the steam fitters when erecting the pipe.

The amount of expansion that can be taken care of by a bend depends upon the radius of the bend and the size of the pipe.

The rule given for the making up of expansion bends is to have the radius of curvature to the center of the pipe not less than 5 pipe diameters and to have the length of straight portion at the end of the bend at least equal to the diameter. Where there is a reverse bend it is best to allow from 6 to 12 in. between the curves in order to give better chance to work on the bends. Further data as to length of pipe needed in bends and length of run cared for by common bend will be given in the July issue.

The expansion in a pipe run may also be taken care of by a corrugated copper section or a diaphragm.

Wainwright Expansion Joints

IN the Wainwright joint made by the Alberger Condenser Co., New York, N. Y., no stuffing boxes are employed, yet the compactness of the slip joint is secured. The joint is no larger than the diameter of the

flanges of the pipe in which it is inserted and is so made that it can readily be covered with non-conducting material to prevent radiation. For high pressures it consists of a main corrugated tube of soft copper with an inner cylindrical slip tube of hard composition and triangular equalizing rings of cast iron. Connection is made by flanges of cast iron or steel, attached to the outer copper tube by a turned-over rim.

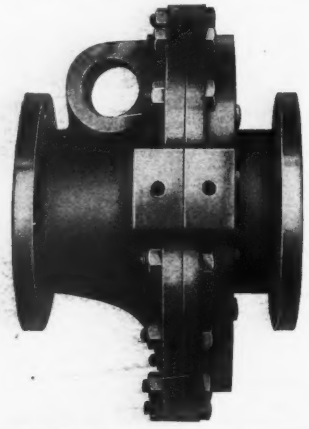


FIG. 6. SINGLE DIAPHRAGM EXPANSION JOINT

The corrugated tube withstands the internal pressure, making an absolutely tight connection from one end to the other, and the equalizing rings limit the movement of the corrugated tubes in any one section, thus causing each one of the corrugations to take up its part of the travel. The re-inforcing rings on the outside of the tubes assist also in holding high steam pressures as well as equalizing the movement.

In connection with the use of expansion joints it is necessary to anchor and guide the pipe line, and some

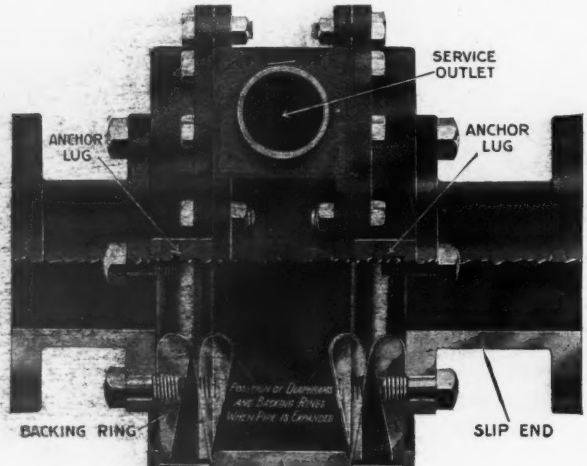


FIG. 7. INTERIOR VIEW, DOUBLE EXPANSION JOINT

of the methods of using expansion joints, anchors and guides are shown in the group illustration. The anchor is made with a fixed base which grips the pipe by means of a corrugated saddle and clips, while the guide has a base carried on a roller so that it can move back and forth with the come and go of the pipe.

In installing a system with these appliances, the guides may be supported on wall brackets, as there is little or no side strain on them, but anchors should be supported always on rigid foundations or, if wall brackets are used, the anchors on each side of an expansion joint should be connected by a tie rod which will prevent any side movement; this method is only advisable for smaller sizes of piping or for short lengths.

Guides should always be placed in a vertical position except for vertical runs of pipe, but anchors may be placed in any position. Anchors and guides are made for all standard sizes of pipes and may be used with either cast-iron, wrought-iron or steel. They should be put up rigidly, as the expansion joints are strong and powerful to take care of the strain of high pressure.

When covering expansion joints 2 overlapping tubes of sheet iron should be placed over the rings of the joint before applying non-conducting material, so as to keep the material out of the convolutions. Anchors and guides will take care of themselves.

In tightening the straps and bolts of the anchors and guides, the nuts should be set up while the pipe is cold. Any slippage or movement of an anchor defeats the entire purpose of the device and may result in the expansion going in some direction where it is not desired, with consequent damage to machinery. Where more than one expansion joint is needed to take care of the expansion of a pipe line, an anchor should be placed between them.

TABLE I. COEFFICIENTS OF EXPANSION OF METALS

Portion of its length which a rod of metal expands for 1 deg. rise of temperature, at different temperatures.

Temp. Deg. F.	Coefficient. Cast Iron.	Wrought Iron.	Brass.
50	0.00000580	0.00000638	0.00000927
100	0.00000600	0.00000660	0.00000960
150	0.00000612	0.00000673	0.00000980
200	0.00000626	0.00000688	0.00001002
250	0.00000642	0.00000706	0.00001027
300	0.00000660	0.00000726	0.00001056
350	0.00000677	0.00000745	0.00001083
400	0.00000700	0.00000770	0.00001120
450	0.00000720	0.00000792	0.00001152
500	0.00000740	0.00000814	0.00001184
550	0.00000765	0.00000842	0.00001223
600	0.00000791	0.00000871	0.00001266
650	0.00000820	0.00000902	0.00001312
700	0.00000855	0.00000941	0.00001368
750	0.00000885	0.00000973	0.00001416

Diaphragm Expansion Joints

THE Central Station Steam Co. of Detroit has recently placed on the market a new and improved type of packingless, diaphragm expansion joint. The accompanying interior view of a double joint shows the construction and method of operation.

The double joint consists of 2 annular diaphragms of heavy cold-rolled and annealed copper, clamped at their outer edges between a cast-iron "inner ring" and 2 cast-iron "outer rings," and having their inner edges spun through and around the inner edges of the cast-iron "backing rings." The copper is brought far enough up on the outside face of the backing ring to permit of clamping it securely between the backing ring and the "slip end" which is a short, flanged, cast-iron nipple. The outer ring, inside of which and concentric with which, the backing ring is located, is recessed to a depth considerably in excess of the thickness of the backing ring.

In operation, the joint is placed in the pipe line with the slip ends and backing rings drawn out to their farthest limit. The inner ring and outer rings are rigidly anchored, by cast-iron lugs, into the concrete or brick box built around the joint, and service pipes to the buildings on each side of the street are connected to the service outlets.

As the pipe expands, the slip ends and backing rings move toward the middle of the joint and the copper diaphragm, which touches the backing ring only at the inner edge when the pipe is contracted, is now drawn close over the backing ring which reinforces it and carries the pressure of the steam.

Very few parts enter into the construction of this device; a double joint capable of taking up the expansion of 100 ft. of line, having only 9 parts exclusive of bolts and anchors. The diameter is also small, resulting in a saving in cost of the masonry work around the joint.

Diaphragms are smooth, without corrugations which might crystallize and break in service, and changes of position due to expansion bring no tensile strain on the copper. Moreover, the maximum bending of the copper at any point, due to change of position, can not exceed 10 deg.

A large factor of safety has been provided in the length of traverse. The general practice is to provide

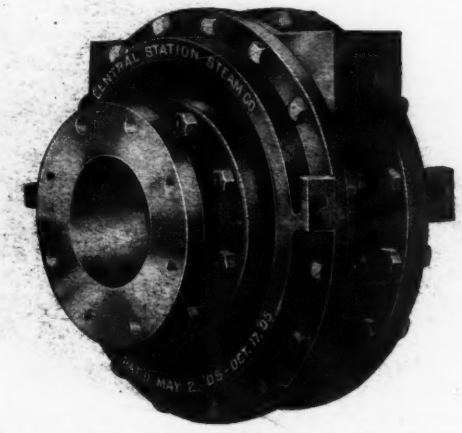


FIG. 8. EXTERIOR, DOUBLE DIAPHRAGM EXPANSION JOINT

for 7/8 in. expansion in 50 ft. of line but these joints are designed to permit of 1¼ in. in that length.

The backing ring, which forms the reinforcement for the copper diaphragm, is one solid heavy iron casting presenting a smooth unbroken surface to the copper.

The single joint is similar in construction to the double joint except that it has but one diaphragm and is designed to take up the expansion in only 50 ft. of line. The construction is fully covered by patents.

F. C. HOLLY

IN connection with the development of power in the Southland, Mr. Holly has been earnestly and effectively active. His working career started in 1890 connection with the erection of 2 triple-expansion pumping engines at the Alum Creek Station, Columbus, Ohio, for the old Holly Co., of Lockport, N. Y., who at that time were prominent builders of pumping engines. Mr. Holly was interested with his father in this work and remained with the Holly Co., with the exception of part of a year with the Tonawanda, N. Y., Water Co., for 9 yr., helping in erection and operation of large pumping engines in Columbus, Ohio; Buffalo, Atlanta, Pittsburg, Philadelphia and other cities.

In 1899 he left the Holly Co. and worked for a short time on the road for the Barr Pumping Engine Co., but preferring a more permanent location he took the job of helping to overhaul and repair the Yazoo City, Miss., water plant of the Michigan Pipe Co., and afterward went to Bucyrus, Ohio, for the same company on the pumping plant of that city, thus helping to secure a long term franchise.

In 1901 Mr. Holly went with the Murray Iron Works Co., of Burlington, Iowa, as erecting engineer, the first engine installed being the municipal power plant at Gladstone, Mich.

Beginning in 1903 a year was spent in a return to erecting for the Barr Pumping Engine Co., for whom engines were erected in Trenton, N. J., Plymouth and Brockton, Mass., at the end of which time the position of assistant superintendent of the Producers' Cotton Oil Co., at Yazoo City, was accepted; but the love of the South was not yet firmly implanted and Mr. Holly

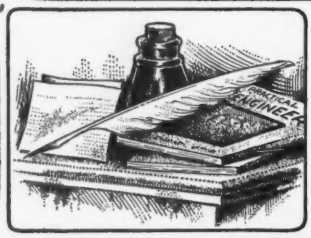
F. C. HOLLY

returned to the North in 1904, erecting engines and mill machinery in Michigan. The call of the South was strong, however, and he soon returned to Mississippi as chief engineer for the Port Gibson Oil Works, preparing for that plant plans and specifications, also purchasing machinery and superintending erection of the Port Gibson Brick & Tile Co.'s power plant.

After 2 yr. with this concern he accepted the position as superintendent with the Producers' Cotton Oil Co. in 1907, a position which he holds at the present time.

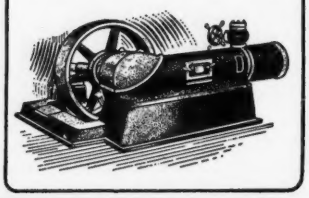
Besides being a first grade member of the Oil Mill Superintendents' Association, Mr. Holly has, during the present year, organized the Col. Goethals Branch No. 1, District 9, of the Institute of Operating Engineers and is chairman of this branch. It was the first branch to be organized in the South and the second branch in the country to complete its organization.

WORCESTER, MASS., N. A. S. E., has recently formed classes among the members for study in the use of the slide rule. Brother A. L. Allen of No. 4 is in charge of the classes, and at a recent meeting, which was attended by a representative of Practical Engineer, he gave a lecture that fully attested his thorough familiarity with his subject, and his ability as an instructor. There was a large attendance of members who gave evidence of their interest and appreciation by warm plaudits and a unanimous vote of thanks.



Letters from Engineers

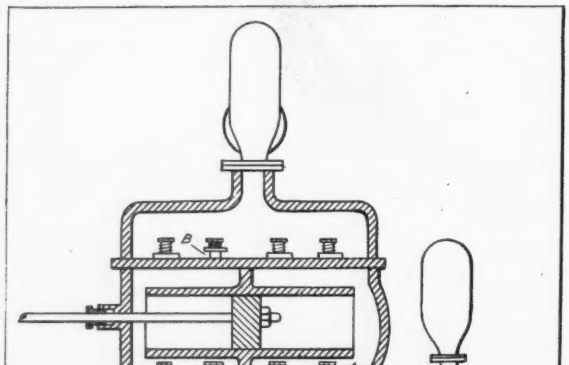
Bright Ideas direct from the plant. Send us yours. Cash paid for those accepted. Sketches desirable; we make the drawings



WORRIES OF THE DUPLEX PUMP

TO the young engineer the duplex steam pump proves a constant source of annoy, sometimes he will work on one for an hour or more and carefully examine everything without finding anything wrong, and puts the parts together again, gets everything ready to start, turns on the steam, and to his great surprise the pump works all right; he is at a loss to know what was wrong with the pump, and soon begins to think that the duplex pump is a great mystery.

Strictly speaking, the duplex pump is a simple machine, and when it refuses to work properly the cause is always found to be simple and easily remedied when one is able to locate the trouble. For example, after a pump makes 2 or 3 strokes, and then gives a sudden jerk, the experienced engineer will look for a broken or missing valve in the water end.



WATER VALVE ARRANGEMENT IN A DUPLEX PUMP

I remember my first experience along that line, I thought the trouble was with the steam valves. So after removing the steam chest cover and working on the valves for an hour or so I finally came to the conclusion that I did not know how to set them properly. Do not touch the steam end unless you are sure that the trouble is there, for in nearly every duplex pump the valve motion is so constructed that it is impossible for the valve setting to change without breaking the connections. The proper way to set the valves is as follows: Move the steam piston towards the steam cylinder head until it comes in contact with the head; make a mark on the piston rod at the face of the stuffing box follower on steam end; then move the piston in the opposite direction until it strikes the other head, and make another mark on the piston rod, exactly half way between the stuffing box follower on the steam end and the first mark. Then move the piston back until the middle mark is at the face of the piston-rod stuffing-box follower on the steam end. This operation brings the piston exactly in the middle of the stroke.

Next take off the steam chest cover, place the slide valve in the center, exactly over the steam ports; place the slide-valve nut in exact center between the jaws of the slide valve, screw the valve rod through the nut until the eye on the valve rod head comes in line with the eye of the valve-rod link; slip the valve-rod head pin through head and the valve is set. Repeat the operation on the other side. If this has been properly done there is no way for the valve to get out of place unless the cross head slips or valve stem breaks.

When the piston on either side of the pump jumps back suddenly, one of the suction valves in the end towards which the piston jumps is either broken or out of place, or some foreign substance is lodged under the valve, and holding it up, so that the water is allowed to escape back into the suction chamber, or the trouble may be found in the discharge chamber of the opposite end. In the illustration, if valve A was out of place or broken it would not make any difference to the stroke when the piston was moving in the opposite direction, for valve A is a suction valve and would be open during that part of the stroke, but on the return stroke the water would flow back through valve A into the suction pipe, consequently there would be no resistance on the piston during that part of the stroke and it would naturally come back with a jerk. This action indicates something wrong with the suction valves.

If the discharge valve is missing the action is practically the same. If the discharge valve B is out of place the water will flow back through valve B into the suction chamber, as can readily be understood. By watching this action of the pump carefully the engineer can easily tell just what suction or discharge chamber is at fault and thus save himself much trouble and work.

Knocking in the water is a frequent trouble in pumps, and may be traced to several causes. Sometimes there is a leak in the suction line, especially when the lift is high. A small amount of air in the suction line, drawn in under a vacuum, will occupy a large space and when compressed by the return stroke will allow the piston to travel a part of its distance before it strikes the water, and this results in a heavy knock, which jars the whole pump and connection. The air leak may be found in the gasket around the stuffing-boxes. When the suction pipe is long, the column of moving water in it gains considerable force, and to bring this body of moving water to a sudden stop, as is done in some cases, it is reasonable to expect a knock or water ram. This is generally caused by a delay in the stroke of the opposite side of the pump and thus preventing a uniform flow of water in the pump.

This knock may be greatly overcome by installing an air chamber on the suction pipe, the air chamber should be placed in direct line with the suction pipe,

because if the water has to change its course at each stroke of the pump in order to enter the air chamber the cushioning effect will be lost. The discharge side should also be provided with an air chamber, but when this chamber is filled with water it is useless, the air in the chamber is sometimes lost by absorption and by leakage; to overcome this a small pet cock should be placed in the suction pipe next to the pump, when the air gets low this cock can be opened slightly and as much air admitted as the pump will stand without knocking; the cock may be left open until sufficient air has accumulated in the chamber. In some cases it is necessary to leave this cock partly open while running to put the proper amount of air in the chamber.

Where the water contains much foreign matter such as mud, grass, etc., it gets on the strainer and partly chokes it up and prevents the cylinder from filling at each stroke; in this case the pump acts as though the suction pipe leaked. To test this out place a vacuum gage on the suction pipe near the pump and if the gage shows too much vacuum for the lift it indicate a clogged strainer. Too much friction is often caused by packing the piston too tight, the square packing used for this purpose is hard and swells some when it becomes wet, and care should be taken not to get it too tight on the start. It is better to have the packing a little loose and to lose some water by slippage past the piston than to use an extra amount of steam to overcome the friction caused by too tight packing.

In packing the piston in the water end great care should be taken to have it nicely fitted, it is a good plan to soak the packing in warm water, to swell it to the regular working size. It should be cut with a lap joint, and when placed in the stuffing-box each joint should come on the quarter of the other ring; if this is carefully done and each ring given an even bearing on the other, the packing will give better satisfaction and last much longer. The packing will wear much longer and the rods kept in better condition if an oil cup is placed above the rods and the packing lubricated in this manner, or if one has no oil cup handy, a good plan is to take a piece of thin metal about an inch wide and wrap it with candle wicking, then bend it around the rod and fasten it next to the stuffing box. Keep this ring well saturated with engine oil and it will prove to be a good lubricant.

E. Moran.

CONDENSATION IN HEATER

I NOTICE a letter in the April issue, signed by F. E. B., entitled "Difficulty With Feed Water Heaters," and have carefully looked over the diagram showing this installation.

I notice the remark: "We find that it condenses 4 barrels of water per hour from our exhaust steam, etc.", and that there is a suspicion that the heater, in view of the fact that so much condensation comes from this heater, is leaking.

If the writer of the article was familiar with the amount of exhaust steam it requires to raise a certain volume of water from, say, 50 deg. to 210 deg., he would not be surprised at this amount of condensation. Inasmuch, as he has not given the temperature of the water, I am assuming these to be about the conditions, and in order to accomplish this, at least 4 barrels of 50 gal. each would be about the amount of water represented.

One strange thing, however, is that "when No. 1 heater is out of commission, there is no condensation." It is quite evident that for some cause or other, No. 2 is accomplishing little or nothing in the way of heating water, and No. 1 is doing all the business. There must be some defect in No. 2, or it would do its proportion and give the same amount of condensation as No. 1.

Heater No. 1, performing all the service, induces the flow of exhaust steam, and in all probability, but little passes through No. 2, as these closed heaters are really condensers, and where the largest amount of condensation takes place, the steam will be induced to travel.

Instead of looking for trouble in No. 1, because of the large amount of condensation, we would look for it in No. 2, and ascertain why this is rendering little or no service. I cannot understand why 2 heaters should be installed in this lay-out, as one would be very much more simple, both in the way of installation and up-keep.

I hope these remarks will throw some light on the subject and that F. E. B. will not suffer any further disturbance on account of the large quantity of condensation, but will rather see to it that heater No. 2 is placed in condition to take its share in heating the feed water, and incidentally produce its share of condensation.

Henry Sims, Pres. The Sims Co.

In regard to F. E. B.'s feed water heater troubles, I do not think he is getting any too much condensation if it is 4 barrels, as he states. A closed heater will condense about 1/7 of the weight of the boiler feed water supplied, so that if he is using his boilers up to capacity he is probably using 300 × 30 = 9000 lb. of water per hour. This would condense 1/7 of its weight, which would be 1286 lb. or 154 gal. or a trifle over 3 barrels. I would suggest, however, that perhaps the heater drains from No. 2 might drain into No. 1 if the drains are not provided with checks. It is feasible to heat the water in the breeching as is proven by the economizer. It is, however, not advisable to install one in a plant as small as this.

Oscar J. Richmond.

VALVE ACTION

ON page 371 of the May issue I note the answer to a inquiry of M. A. P. relative to point of cut-off. It seems to be thought that problems of that nature cannot be solved by arithmetic, but there is a rule which is in use in English practice, that serves admirably. Here it is: 2 times the lap plus the lead, divide by the travel of the valve, square the quotient and multiply by the stroke gives the number of inches of the stroke left to be completed after cut-off has accurred. This rule does not take into consideration the effect of angularity of the connecting rod, which, of course, depends upon the length of the rod in relation to the stroke of the piston. The rule is, however, very useful and not at all difficult to remember and to use.

Applying it to the problem submitted by M. A. P., and assuming that no lead is to be given the valve, the statement will appear like this: $(2\times1.375+0\div5)\ ^2\times20=6.05$ in. of stroke after cutoff, or 20—6.05 =13.95 in. up to cutoff.

This differs but little from the result found from applying the diagram, which result I presume was stated in round numbers as a matter of practical convenience. The rule is sufficiently close for practical

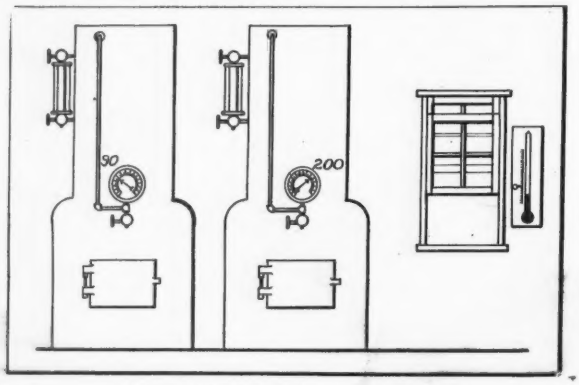
results, when considering average values between head and crank end cutoffs. It can be found in many of the English textbooks and handbooks relating to marine engineering, and seems to have stood the test of time, for I have used it myself for the past 25 yr.

I think it would be a good idea for readers to jot it down in their note books for future reference. Here are some companion rules that also may be of service, pertaining to slide valves: (1) Greatest port opening for steam=travel of valve÷2, from which subtract the lap. (2) Greatest port opening × length of port =port opening area. (3) Opening for exhaust, when crank is on the center=(lap+lead)—exhaust lap.

Charles J. Mason.

FROZEN GAGE

IN a certain plant one cold winter night as Pat was looking over his boilers he discovered a big variation in the steam gages on his 2 upright boilers. The 1 boiler registered 90 lb. gage pressure while the other gage registered 200 lb., and being at a loss what to do, thinking the boiler was going to blow up every minute he sent for Mike, the day man, with all haste, for consultation.



LOCATION OF BOILERS AND WINDOW

Mike looked around and took in the situation and got a torch with all haste and applied it under the steam gage that registered 200 lb., and in less time than it takes to tell you this story the gage pointer dropped back to its normal point, 90 lb., the same as indicated on the other boiler gage. Mike told Pat to keep his windows closed after this, especially when the thermometer pointer registers below zero.

John M. Leitch.

KNOCK IN PUMP

IN a recent issue M. S. has asked for a suggestion in regard to the knock in a Blake pump and I may be able to give a little information regarding the subject. If the pump has a pressure of 350 lb. and the knock in it is in the water end, the packing on the piston may be hard and lets the water get past it and this causes the water to get back in the valves thus leaving the piston much freer than the one on the other side. It may be that the valve rods have been out of order, if so the pump will run all right until it gets about an inch from the end of its stroke and from then on it will run free as it has no suction or pressure to stop the stroke.

I have worked with Blake pumps for 4 yr. and have had the same trouble with them, it being on a ship where we were pumping salt water, on taking out the piston and packing, we found that the latter was hard and very much worn and then after we had removed the packing and adjusted the valve rods, our pump ran perfectly and this may be the same case with the pump in question.

Arthur J. O'Connor.

HOISTING ENGINE POWER

UNDER the head of "Hoisting Engine Queries" in Practical Engineer E. E. H. asks:

"An engine having a cylinder 15 by 24 in. using 60 lb. of effective steam pressure per square inch is direct connected to a drum 8 ft. diameter. Neglecting friction of the engine, how much will the engine lift in pounds?"

To this question the answer given is as follows: "It appears that this is a single engine and the load it will just be able to hold in balance will be equal to pressure times the area times the length of crank divided by the radius of drum; $14^2 \times 0.7854 \times 60 \times 1 \div 4 = 2609.076$ lb. Note that the power must exceed the load before there can be motion. The above result is called the turning moment of the engine. If you double the velocity of the load, it requires the engine to exert double the power, so that the load an engine can hold in balance is greater than the load to which it can impart motion."

Now regarding the rule, in the opinion of the writer, there are the following mistakes which are misleading. First, a typographical error in the calculation, which of course is excusable, as it does not change the principle of the rule, however the answer according to this rule should be 2309.076 instead of 2609.076 lb.

In the beginning he says: "It appears that this is a single engine and the load it will just be able to hold in balance will be equal to pressure times the area times the length of crank, divided by the radius of the drum." Now, we will admit that if the cage could be carefully loaded with a taut rope, with the engine crankpin 90 deg. from center and 60 lb. effective pressure against the piston, the engine would just hold the load in balance, but if the engine should start backwards or forwards to the extent of ⅛ of a stroke, the load would never stop until it struck the bottom.

Again it is stated that it requires the above amount of pull to start the load, there being no slack in the ropes. This is again a mistake, in my opinion, as the above pull will never start the load.

Then it is said that when there is slack mentioned, use the rule following: "Multiply the pressure by the area and by twice the stroke; this gives the work done in one revolution which equals the load times circumference of drum." Now, this is altogether a different rule from the former and will represent 100 percent efficiency of the engine and will just hold the load in balance, or, in other words, the work exerted on the drum will just equal the load in pounds. Let us compare the results of the 2 rules.

The first rule, worked out as just shown, gives 2309.076 lb. load.

By the last rule, we should have $14^2 \times 0.7854 \times 60 \times 4 \div 8 \times 3.1416 = 1470$ lb., or a difference of 839.076 lb. in favor of the rope with no slack. Just what is meant by "slack rope" and "no slack in the ropes" is not clear to my mind and I have hoisted many a load out of the mines. Possibly this is the theoretical side of the question, but in practice, I can say from experience, it is best to keep your ropes taut.

Walt K. Edgar.

In reply to the comment of Mr. Edgar: I have tried to make clear the difference between what the engine will hold in balance and what it would lift in doing a practical day's work. The 2 rules cannot be compared, as one is for doing work and the other is for balance of forces. There is a great difference in the work done by a locomotive moving 1000 tons at 20 miles an hour and another moving the same load at 40 miles an hour over the same track. They can both move it, but one moves it twice as fast as the other and is, therefore, exerting twice the power.

The question read: "An engine having a cylinder 14 by 24 in., using 60 lb. effective steam pressure per square inch, is direct connected to a drum 8 ft. in diameter. Neglecting friction, how much will the engine lift in pounds?"

This question is not definite enough to admit of an answer without making assumptions. In the first place, is the engine single or double cylinder, and is it to be of practical use, that is to say, able to pick up its load and give it such a velocity as will accomplish a good day's hoisting, or is the problem to find just the number of pounds that the engine will hold in balance? Assuming it to be a double engine, since it is directly connected, and is to be of practical use, the second computation given by Mr. Edgar will be correct as to practical load. This is Percy's formula taken from his work on Mechanical Engineering and is certainly one of the best. One-third should be allowed for friction, but the question states that friction is to be neglected.

Because of the form of the question I used a single cylinder and considered the load in balance in my former reply, and this is the point to which Mr. Edgar has taken exception. In practice, of course, this would not do, as the power is needed to start the load and speed it up in order to be of practical utility. Hence the necessity of providing for friction.

If the question means what load the engine will just hold in balance, then the first method of computation is correct and any load less than 2309 lb. could be lifted if there was no friction. A single engine will hold the same load in balance as will a double engine because one of the engines will be on dead center while the other one has the crank at right angles to the line of centers, but in this case no work is done, as the load is not moved. Work is done only when a load is moved.

If the engine is single it is evident that it cannot move the load mentioned. In practice it is found that the load will be 2/3 to 0.7 of that held in static balance, but the engine will not handle the load at as high rate of speed as the double engine, hence will not be doing as much work. J. C. Stewart.

CAUSES OF FLUCTUATIONS IN WATER LEVEL

LOWERING of water level indicated by the gage during the night aside from shrinkage due to temperature may be caused by a number of conditions. Possibly the steam and water capacity of the boiler is insufficient to prevent fluctuations in the water level while the boiler is working. Again, possibly the water surface for the disengagement of the steam is insufficient to prevent fluctuations in the water level. Also, possibly the passages between the different sections are not large and free enough to keep the water level equalized throughout the entire water space of the boiler.

Under the first 2 possibilities, starting the engine would very likely cause the water level, as indicated by the gage glass, to rise up and more completely fill the glass. Then, when the engine is stopped, the water level will be lowered a corresponding amount. This fluctuation in the water level may be accompanied by a fluctuation in the steam pressure and it may not. It makes considerable difference whether the water level was noted in the evening when the engine was stopped or running. All these things must be watched because they have their place and influence. I have operated boilers where the fluctuation in the water level due to starting and stopping the engine measured 2.75 in. in the gage glass.

As to the third possibility, the water level may be raised according to the gage glass by starting the engine, or it may be lowered. The circulation of the water is increased by the boiler supplying steam to the engine. Naturally this is so. And if the restricted passages were equally deficient through the vessel as a whole, the water level may be steady, and it may not be steady, much less could we expect it to be steady if the restricted passages were more deficient, at one end, side or other portion of the vessel than is the case with the remainder of the passages.

The arrangement of the tubes, distance between them, and condition of the surfaces on the water side, as to scale, in tubular boilers have to do with the water passages between the tubes, and also the circulation of the water. Thos. C. Robinson.

COMPOUND GENERATORS IN PARALLEL

REFERRING to L. R.'s query with reference to the parallel operation of 2 compound-wound direct-current generators and the reply, it seems that there are several points which have been overlooked.

Although the compounding of both generators might be identical, trouble might be had with parallel operation, due to a difference in regulation of the prime movers. This item, therefore, should be looked into. This, however, in my estimation, is not so important in direct-current apparatus as it would be in alternating-current where regulation of prime movers plays a very important part.

There is still another item to be considered in the parallel operation of compound-wound direct-current generators, and that is voltage drop across the series fields at normal load. For good parallel operation this voltage drop should be the same upon each generator when operating under full load. This was brought to my attention several years ago when I was called upon to investigate trouble with parallel operation of 2 direct-connected engine-driven compound generators, one a 100-kw. and the other a 50-kw.

After going into the difficulty thoroughly it was found that the voltage drop across the series fields of the 100-kw. generator at normal load was 2 volts, while the voltage drop on the 50-kw. was 1.5 volts or a difference of 0.5 volts. I immediately made a resistance out of sheet iron, the voltage drop of which was 0.5 when full load current of the 50-kw. generator was passing through it. This external resistance was connected in the line in series with the series field of the 50-kw. generator, after which there was no further trouble, and each generator took its proper portion of the load.

It will therefore be seen that it is not only a question of using series shunts properly to obtain good

parallel operation, since in the above case this would never have overcome the difficulty.

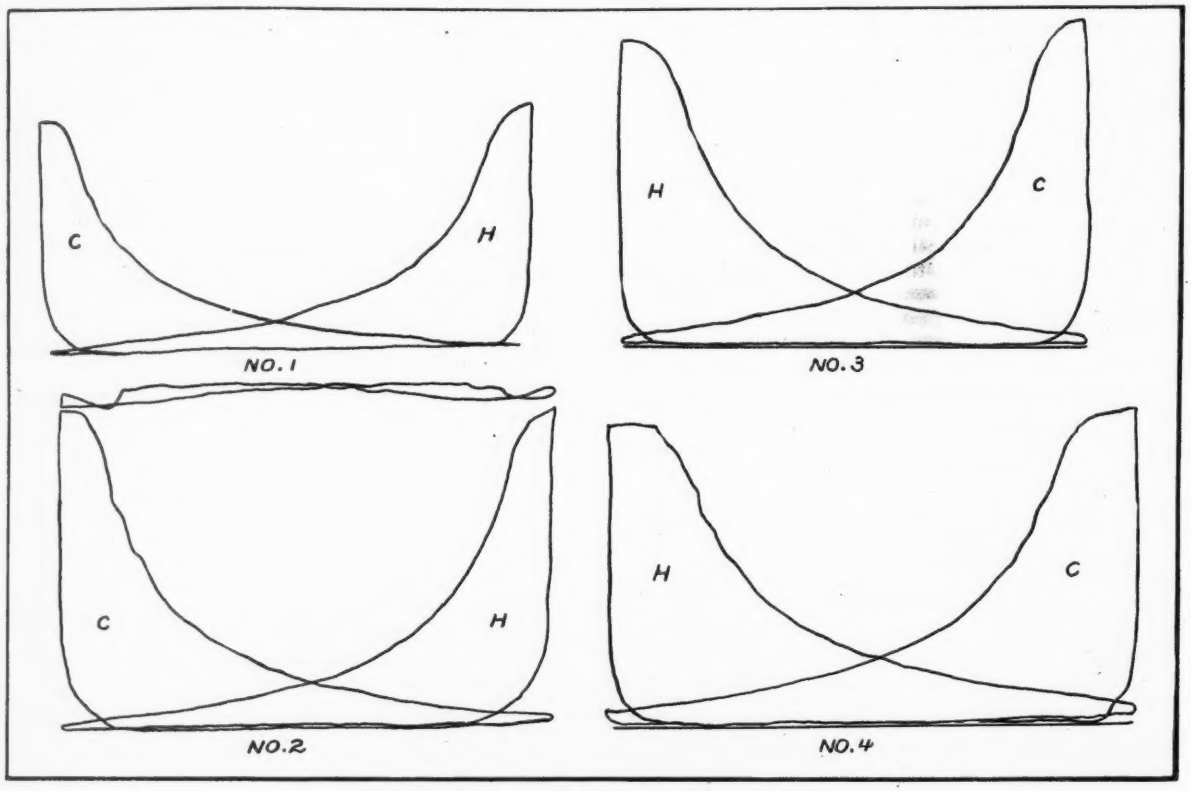
C. L. Thering.

CARDS FROM COOPER CORLISS ENGINE

ACCOMPANYING indicator cards were taken from a C. & G. Cooper Corliss engine, which has been in operation about 8 yr. These cards were taken at intervals during 3 of the 4 yr. that I was in charge of this engine. Cards were taken on an average of about every 2 months and only on 3 or 4 occasions was it necessary to make any change in the setting of the valve, and even then very little.

This engine was operated from Monday morning until Saturday night without stop, or on an average of 148 hr. per week at a speed of 102 r. p. m. with a load ranging from ½ to full load. The size of the cylinder is 20 by 36 in., taking steam at 150 lb. pressure. The cards here shown were taken at random from a collection of about 200 cards taken from this engine with different loads and at different times. These cards show what I believe to be the proper valve setting for this class of engine. Card No. 2 shows a steam pipe diagram taken over the cylinder diagram.

J. C. Hawkins.



CARDS FROM A C. & G. COOPER CORLISS ENGINE

CARD CRITICISMS; BABBITTING SUGGESTION

CORRESPONDENT F. S., page 302 of the April issue, wants to learn something about the indicator diagrams obtained from a tandem compound engine. It looks to me like the deformities in the expansion and compression lines of both head and crank end diagrams in the high-pressure card are caused by leaking exhaust valves or piston, or perhaps both. It is possible for valves to leak at a certain place in their travel and not leak at any other place. This occasionally happens with Corliss engine valves.

If the exhaust valves are leaking at the place indicated by the kinks in the compression curves, the corresponding place on the steam expansion curve should be concave instead of convex, as shown at present. That the expansion curves are convex seems to indicate that the piston is leaking steam from one side to the other just at that part of its stroke. If the valves and piston are leaking, no change in the valve setting will alter to any extent the outline of the diagram.

I would favor less compression on general principles. Half as much as now exists would be sufficient for an engine of the type I imagine the diagrams were taken from, for F. S. does not say what make of engine it is. Judging by the rounding upper corners of both diagrams, perhaps a little more lead would be of advantage.

The high-pressure piston should be tested for leakage at that part of the stroke near the end where the expansion curve "humps" upward. If it is found that steam passes from one side to the other, the defect might be remedied by changing the position of the piston rings, that is, turning them around on the piston so that a new wearing surface will be met all around the entire circumference. It is a good plan to do this occasionally in order to keep the surfaces in good condition.

In the low-pressure diagrams the compression is entirely too much, particularly in the head end, as shown by the loop at the upper left-hand corner. Here, also, the crank and exhaust valve or the piston leaks,

as shown by the kink at the upper right-hand corner. There is hardly any doubt that the engine will run very much better and with less steam, even with the existing supposed leaks, if the compression is reduced to at least one-third of what it is now. Suppose F. S. tries these suggestions to see what he will get, and then reports it in Practical Engineer.

The Allis engine diagrams, C. E. D., page 303, show that the exhaust valves open a little too late and possibly close a little too late, for the piston is not far from the end of its stroke when the valves close, leaving only a small margin. Advancing the eccentric will make an improvement all around. The atmospheric line is so close, in fact, coincident with the back-pressure lines of the diagrams, that it leads one to think the indicator was restricted in some of its movements when taking the diagrams. Here also is an opportunity for experiments to be made and the results given to readers of Practical Engineer.

Finally, I would like to ask Frank Caldwell, page 300, what was the object of boring the babbitted brasses a little larger than the pin, and then scraping them in? If bored a little larger than the pin so that each brass will fit on the pin and bottom, there will not be any need to do any scraping. We formerly did a great deal of scraping in babbitted boxes, prolonging the job at an extra expense, and this after the boxes were supposed to come out of a machine bored to fit the pin for which they were made.

If a pair of brasses that have been babbitted are properly bored out a trifle larger than the pin on which they are to run, the sides eased off for clearance and oil grooves correctly cut, they may be connected up without any scraping to fit and there will be no danger of heating, providing the adjustments are intelligently made. Charles J. Mason.

OHIO STATE LICENSE LAW

D. ROUNDS, in an article on the "Ohio State License Law," some time ago severely criticized the slackness with which the license question is handled in that state. Having been pretty well over that ground, the writer would like to express his opinion on Ohio State License. It was my lot several years ago to go before a district examiner there, for examination. The result was that I came out with a third class license. I took it home and hung it up as required by law, "In a conspicuous place in the engine room."

Everybody who came in looked at it. At first I felt proud of it; but very soon my pride changed to chagrin and I finally became ashamed of it. Hearing continually such remarks as, "Oh, 3d class, hey." "Bum engineer there," "Only a cheap 3d class man," etc. In time I had the opportunity of a better position and the indications were that I was to have a good position, but when the superintendent of the company saw my license marked as it was "Issue 1, Class 3," he gave me the worst job he had.

Now I was heartily dissatisfied and resolved to push up a little and went again before the examiner, after studying and posting up all I could. This time I got a second class license, and had only had it a few weeks when the superintendent chanced to come through the power house one day and saw it. A short time after this I got word that he wanted to see me. He wanted to know how I got a better grade license and I told him. "Well," he says, "you may have charge of ———— station at the beginning of next month." Which was really a much better position and better pay.

I give this as an illustration to prove my belief that the arrangement is not without many good features. It gives young engineers a chance to get a start. If ambitious, however, they will not be satisfied very long with a low class license.

Employers are very frequently like my old superintendent, governed by the class and issue number, in judging an engineer. Of course, this rule has exceptions, but it is more often followed than otherwise. The very nature of the term, "a first class man" carries much weight and the value of the term is well worth the effort to attain it. Edw. T. Binns.

THE MYSTERIOUS LEAK

ONE of those simple mishaps, which sometimes puzzle some wise engineers occurred in the air compressing plant of a contracting company in Michigan where I was working a few years ago. The plant in question supplied power for running 30 or 40 surface rock drills, 4 cableway engines and several derricks, and consisted of 2 Rand-Corliss cross-compound units of 700 and 350 hp.

One night, shortly after coming on watch, the second engineer, who had charge of the night shift, noticed that the air cylinders of the big engine were getting too hot, so he hurried out to the boiler room, expecting to find the circulating pump stopped. It was racing. The second engineer bore the historic name of Wellington, but we boys called him "Welly." Considerably mystified, Welly returned to the engine room and found the compressor so hot that he was obliged to slow it down. Soon he noticed that the vacuum gage was going down. Still he failed to locate the trouble.

The next move was partly to close the water intake of the vacuum pump. This raised the vacuum gage, but made the pump race worse. Then he cut one of the large boiler feed pumps into the circulating system. It also raced, and shortly the vacuum went down again. Still the compressor continued to get hotter. At this stage he sent for the chief. The chief arrived, rubbing his eyes, looked the situation over and "guessed there must be some gravel or scale stuck in the piping." And the 2 pumps racing away past the safety limit! He failed, however, to suggest a remedy and the engine was slowed down to less than half its usual speed. The air pressure out on the works went down, but "we can't help it," said the chief.

All this time—over 3 hr.—Welly had been flying from the engine room to the boiler room, from the boiler room to the gage board in the engine room, from the gage board to the cellar where the vacuum pump was, and back over the rounds again in such anxious haste that he had scarcely time to think. On his hundred and second trip to the condenser he happened to cast his eye to the ceiling over the condenser, and a whole flood of light surged through his mind. On the top of the condenser and leading off toward the boiler room was a 1¼ in. pipe which he remembered was connected to the circulating system and had been used to prime the vacuum pump. A globe valve was located in this pipe near the condenser, and he reached his hand up to see if it was open. It was. A few twists of the wrist closed it, and then he went upstairs, cut out the boiler-feed pump and regulated the circulating pump. By this time the compressor was

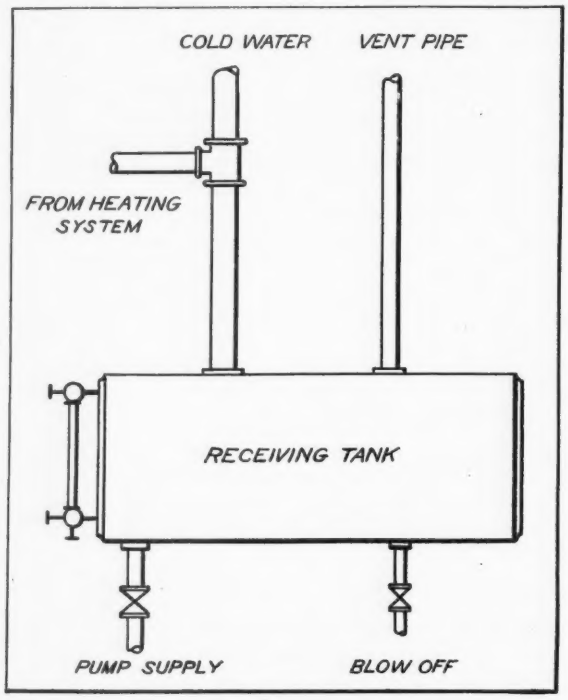
cool enough so it was safe to speed her up. The chief either did not know what had happened or pretended not to. He departed for his bunk remarking that "the scale must have got moved out." Welly was at the time laboring under a very strong suspicion that a trick had been played on him, so he made no explanations. About 2 yr. afterwards he told a couple of us boys what the matter had been and he stated that he was going to tell the chief. Neither of them had breathed a word about the incident in all that time. And Welly is still wondering how so much water could possibly get through that 1¼-in. pipe, and how the valve got open.

Oren Crowder.

EXHAUST STEAM AND THE PIPING

I NOTICE in one of the issues a question about using exhaust steam in the kiln. If I were engineer in that plant the kiln would never get any live steam when I was running the engine, but the writer did not say whether the exhaust steam is used for anything else or goes to waste. If he has an open heater and puts a good oil separator on the exhaust line between the engine and the coils, the steam can go in one end of the coils and the return from these coils go to a trap or traps and discharge from the traps to the open heater.

If he is using a closed heater I would pipe the exhaust direct to the coils in the kiln, but in either case



PIPING FOR A RECEIVER TANK

a back-pressure valve should be put in the exhaust line near the engine and set at the pressure he wants, so not to throw back pressure on the engine. If he uses a closed heater and lets the steam go right through the coils and blow out to the air at night, he should put on a steam trap at the discharge end and watch the results. I have seen plants where they used live steam to head with and on the return end had a globe valve. They would just crack this valve and in a short time after it had been opened you could see steam blowing right through. Such use is very hard on a valve and there are few that will stand it for any length of time without getting leaky. Either the disk or the seat will become scored. By putting a good trap on the end it will take care of itself and prevent blowing through of steam.

I note also a question in regard to a pumping problem and an explanation which does not seem to answer the original question. I am positive that a pump cannot draw all the water out of a closed tank. It can take some of it out but when it gets a sufficient quantity so that there is a vacuum in it, unless he lets air in to take its place, the water will not come out. Also, I would not pipe a receiving tank as described in the article. My idea would be to have a vent pipe as shown on the sketch, run up through the roof with no turn in it, if possible, but with no check or other valve on it. Then you will always have something for the pump to work on. I have put in a number this way and have never had trouble with any of them.

H. Armstrong.

FLAT ECCENTRIC; SHORT STROKE PUMP

IN regard to that eccentric which wears flat, I think this is caused by a soft casting and a hard strap being run close, as I have had the same experience and first tried to stop it by putting a sheet steel band 1/16 in. thick around the eccentric and filing the strap to a fit. This stopped the wear all right, but I could not get it to run cool without a large amount of grease, and when loose the rattle was worse. So I turned the inside of the strap out and then babbitted it, which made it work like a charm. I think if he has his strap babbitted he will find the wear will stop.

H. C. G. asks which will give the best results, running a canvas belt or a rubber one in a damp place. I think the canvas will, for a rubber belt will wear through in a short time and become ragged, and it will stretch more than the canvas and need more taking up. He asks for a better way of holding the belt together than the rawhide lace. I think a belt should always be glued if there is time and material on hand to do it with, otherwise lace it with metallic or wire lace, as this gives as smooth a joint as glue but not quite so strong. It is, however, stronger than rawhide. Do not use cleats to hold a belt, for if they start to go they will take a piece of belt with them.

He also asks a cure for a short stroking Dean pump. The difficulty is common, and tightening the valve rod to produce friction generally stops it until the rod gets worn out, which is the objection to this method. A better one is to put a ring on each end of the plug valve which is causing the shortening of the stroke, as it is loose.

W. F. Crowther.

KEROSENE ON VALVE

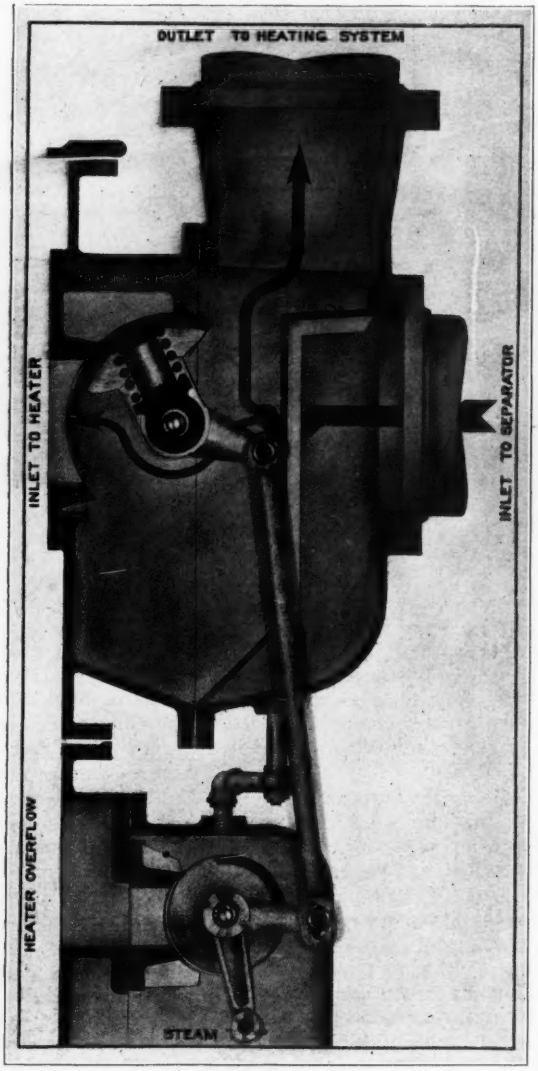
I HAVE a number of reducing valves on steam lines and had a great deal of trouble. Instead of taking them apart I tried kerosene oil in the valves and I have had no trouble with them since.

John W. Banks.

ORIGINALITY AND INITIATIVE are nothing more or less than getting 100 per cent action into things before someone else comes along and does what you intended to do. Put your dreams into action and get the benefit of a restless night.

AN INSTRUCTIVE MODEL

PERSONS having a liking for mechanical devices will be interested in an ingenious model, now being distributed by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., to illustrate the valve-timing gear in the new Cochrane Steam-Stack and Cut-Out Valve Feed Water Heater and Receiver. The model, which is constructed of stiff celluloid, illustrates neatly the fact that when the heater is cut off from the exhaust steam supply, the separator attached to and forming a part of the heater continues to furnish exhaust steam purified of oil to the heating or drying system, while the trap is cut off from communication with the heater, but still continues to drain the separator.



MODEL OF VALVE TIMING GEAR IN STEAM STACK FEED-WATER HEATER

Communication between the separator and the heater and between the trap and heater is controlled by 2 semi-rotary or Corliss valves. In the case of the steam valve, the opening is quite large, and the valve when closed receives the pressure not only of springs, but also of the back pressure carried on the engine. Inasmuch as this pressure, multiplied by the large area, might create sufficient friction to render the opening difficult, the valve gear is so arranged that while both valves are opened from one handle, the small valve between the trap and the heater opens first, letting pressure from the exhaust line into the heater to balance the pressure on the steam valve, which is next opened by continuing the motion of the handle. In closing the valve, a similar process is carried out, that is, the larger valve closes before the smaller valve has entirely cut off communication between the exhaust steam line and the interior of the heater.

The proper timing of the motions is secured by connecting the cranks attached to the respective valves. The link, however, is slotted, permitting the smaller valve a certain excess of motion after the larger valve has come to rest in closing and before it begins to move in opening. Aside from the benefits in the ease of handling above mentioned, the operation of both valves from a common handle has the inestimable advantage of preventing oversight or mistakes. That is, it is not possible to neglect to open the drainage valve when putting the heater in operation and thus to cause water to back up in the heater. Once the valves have been closed, the operating handle can be removed, making manipulation of the valves, and possible scalding of men during cleaning, impossible.

As compared with ordinary methods of connecting up open feed water heaters and receivers, with an independent oil separator in a by-pass to the heating or drying system, controlled by independent valves, this arrangement has the further important advantage that it is impossible to stall the engine by closing certain valves, or to throw high pressure steam into the heater. Upon the reverse of the model it is stated that full particulars regarding the application of these heaters in connection with all kinds of exhaust steam heating systems are fully explained in the "Exhaust Steam Heating Encyclopedia" published by the manufacturer, which with the model, is sent gratis to persons who are interested in the design, installation or operation of exhaust steam heating systems, and who state the name of the concern with which they are connected and the use at present made of the exhaust steam.

AN IMPROVED BALANCED AUTOMATIC GOVERNOR

IN the early days, when the steam engine was generally used for driving flour mills, pumping water, etc., and the matter of constant speed was not of much importance, the old flyball or pendulum governor developed by Watt was all that was required. When the steam engine came to be used for driving generators, however, and especially for lighting service, it was soon evident that a variation in speed of even 2 or 3 per cent produced an annoying flickering of the lamps and that a more sensitive governor was necessary. As the flyball type had many inherent disadvantages, the automatic shaft governor was developed and used on electric lighting engines, especially the high-speed type used for lighting service.

One of the disadvantages of the pendulum governor is, that as these governors usually actuate a throttle valve in the steam line, there is a certain time lag between the time the steam leaves the throttle and when it reaches the piston. The drop in

pressure caused by the throttle valve also reduces the effective energy in the steam which the engine could convert into work.

The shaft governor is open to neither of these objections, for it works directly on the steam valve, so that there is no time lost between the regulation of the steam supply and its application to the piston.

These automatic governors consist essentially of a weight within the flywheel supported eccentrically to the shaft and connected to the valve rod by suitable links. Centrifugal force is opposed by a spring which draws the weight back to its normal position when the engine is at rest. One serious objection, however, to most of these governors is that no allowance is made for the action of gravity upon the governing weight. That is, when the weight is over the shaft, gravity tends to bring it nearer the center, and when it is below the shaft, gravity tends to draw it further away from the center; thus there is a periodic shifting twice in every revolution which varies the setting of the valve entirely independent of the speed of the engine.

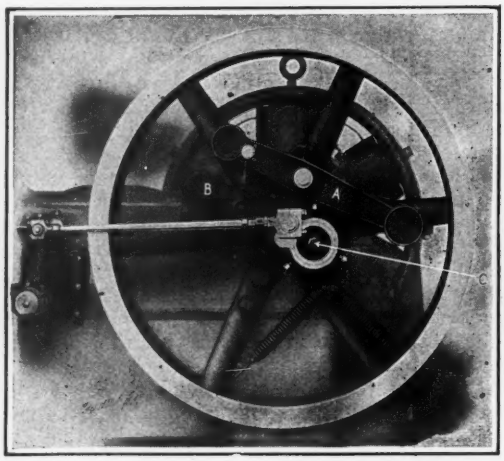


FIG. 1. BALANCED SHAFT GOVERNOR OF AMERICAN ENGINE

In Fig. 1 is illustrated the governor which is used on all types of the American engine, but was developed especially for use on the angle compound type. This governor was designed with the idea of perfecting a governor which would not be influenced by gravity and which would regulate the valve so that a constant speed would be maintained, no matter what the variations in load upon the engine.

The American balanced governor consists of an arm, pivoted at some convenient point and having a weight at the right hand end which is acted upon by the centrifugal force. Connected to this by means of a link is another lever, which carries the pin that determines the throw of the steam valve. This second lever is free to move about a center and change the eccentricity of the valve pin by an amount depending upon the position assumed by the first lever, which in turn depends upon the speed of the engine.

The second arm is so designed that its center of gravity coincides with the center of the shaft; therefore, the speed of the engine does not tend to move it one way or the other, and in order to counteract the gravity effects mentioned above, the arms are so proportioned that their centers of gravity always balance each other, no matter what position the engine shaft is in. The engine can be stopped in any position and gravity will not tend to shift the eccentric pin; whereas, had the second arm been omitted, the position of the eccentric pin, upon the stopping of the engine, would depend upon whether the weight were above or below the center of the shaft.

Another improvement is the use of 2 braced springs. These springs are so braced that they resist gravity and centrifugal force, and are not subject to the swaying and bellying met with in single springs, especially when operating at high speed. These springs also provide means for making slight speed adjustments. If the speed be unsteady under load, a slacking of the radial spring and a tightening of the other one reduces the variation, while the reverse operation increases it. To increase the speed 2 or 3 revolutions the nut at the junction of the 2 springs can be tightened a little. The possible speed

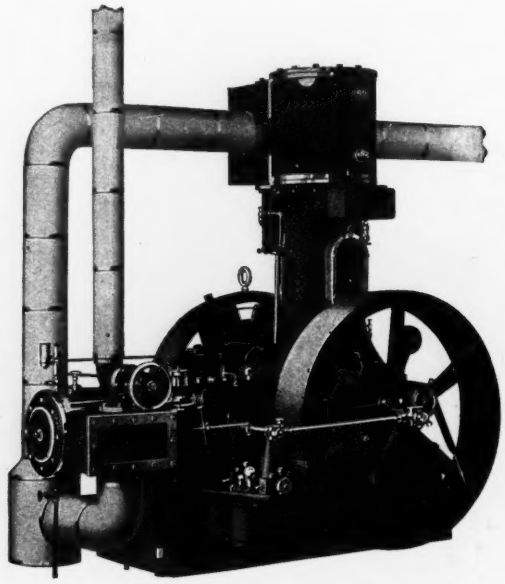


FIG. 2. AMERICAN ANGLE COMPOUND ENGINE

change by this method is not very great. It is, however, of great importance where several machines are to operate alternators running in parallel. To make a greater change in speed of the engine, weights should be taken off or added to the right hand end of the first arm.

All of the mechanical details of this spring have been carefully worked out, such as the use of a knife edge where the link connecting the spring to the arm is attached to the latter. Two stops on the arm prevent the governor from shifting beyond certain limits.

It should be noted that governors on the angle compound engine are not subjected to the racking and vibration that is usually met on single engines for the reason that the angle compound engine is so perfectly balanced that practically no vibrations are set up. Thus there is nothing to loosen the adjusting screws on the governor.

This type of balanced shaft governor is now supplied on all engines built by the American Engine Co., of Bound Brook, N. J.

AN ENGLISH ENGINEER estimates that every fifteenth inhabitant of the British Isles uses a bicycle or motorcycle for business or pleasure. The British postal service alone utilizes 11,400 bicycles.—Popular Mechanics.

Questions and Answers

To help you when in trouble; give name and address. If quick answer is wanted, enclose a stamp for reply.

THE CHIEF ENGINEERS' CATECHISM, II

WHAT are the meanings of fixed carbon, ash, volatile matter, moisture, as related to coal?

2. How do anthracite and bituminous coal compare in regard to these quantities?

3. What is the difference in boiler setting required when burning anthracite, and when burning bituminous?

4. What is the ratio of grate surface to heating surface for best practice in different types of boilers?

5. What should be the ratio in cubic feet between the fire-box and the combustion chamber for different kinds of coal?

6. How is draft measured and where is the measurement usually taken?

7. What are carbonates and sulphates?

8. Why are they found in natural waters?

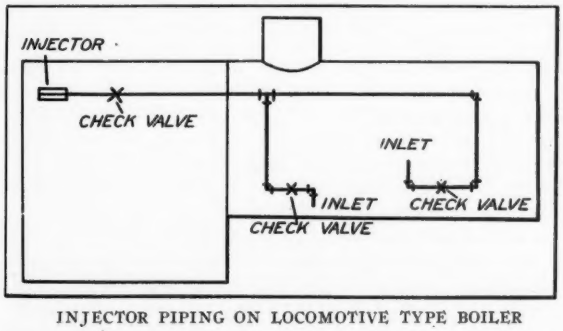
9. What is the highest amount of carbonates and sulphates likely to be found in waters?

10. What temperature is required to remove carbonates and sulphates?

(Answers to these questions will appear in the August number and must be in this office not later than July 1.—Editor.)

Injector Question

AN injector on one of our boilers was connected as shown by the sketch herewith. The discharge from the injector was through a check valve near the injector and then through 2 feed-water outlets, with a check valve on each. I did not have the opportunity to test it, but it did not work very satisfactorily. It



INJECTOR PIPING ON LOCOMOTIVE TYPE BOILER

was bucking all the time and I want to know whether it would make any difference having the connection through the 2 check valves instead of through a single check valve and inlet. Have readers any experience in this line? H. E. H.

Voltage Falls Off

A CORRESPONDENT has the following difficulty with a gas-engine driven compound wound dynamo, carrying 25 lights and about 28 amperes power load at 110 volts. When started up at the proper speed the voltage under load is 110, after about an hour the voltage drops to 90, although the speed remains the same. No regulator is used in the shunt windings; the machine runs quite cool and all connections have been tested and found correct. Can anyone suggest the cause of the drop in voltage?

Drying Grain

TO what temperature do I have to heat air to drive the moisture out of it and make it dry air? What would you advise as the best way so to heat the air?

To give you an idea what I am trying to do, will give you a little description as follows: I have a galvanized drum 10 ft. long with a conveyor and beaters which keep the wheat stirred up as it passes through it. I am trying to dry this wheat bone dry as it passes through. It can not come directly in contact with steam pipes as it is liable to scorch. I have a coil of steam pipe around this drum, but do not get a high enough temperature and the air in the drum remains moist.

I have a fan that I can connect up and blow the air into this drum if I knew how to heat the air to a temperature high enough. J. U. K.

A. Heating air does not drive the moisture out of it, strange as that may seem, but it gives the air a greater capacity to absorb moisture. When air is heated it has the ability to take up more moisture than it already has, and if it be cooled it will give up some of the moisture already carried. The higher the temperature of the air, the greater amount of moisture can it carry. Therefore, whenever you heat up air and keep it away from water you increase its capacity to take up moisture.

The only thing you can do under your conditions is to heat the air as hot as possible, keeping it at the same time away from any water and then blow it through your drying drum. It will absorb moisture from the wheat and carry it away. Of course, when you heat the air in the drum and leave it stationary, the hot air takes up moisture from the wheat but can only take up a certain amount. You must have a current of the heated air passing over the wheat, taking up moisture and carrying it off, in order to get the drying effect that you want.

The best way to heat this air will probably be to pass it through the tubes of a device like a closed feed-water heater, only with many more tubes and smaller in diameter. The hot gases or flames would then be sent around these tubes, or you can reverse the process and send the hot gases or flames through the tubes and pass the air to be heated on the outsides. It will not do to treat the air with a flame direct, because water is formed in the process of combustion and you will get a good deal of moisture into the air in that way.

Crank Shaft Formula

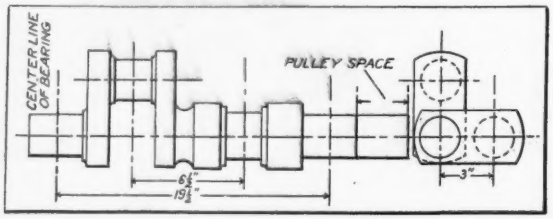
YOU will find enclosed herewith a sketch of an automobile type crank shaft for a steam engine. I would like to get a formula for figuring the size of the shaft made of forged steel. It is supported by 2 bearings, one at each end. The diameter of cylinder is 5½ in.; mean effective pressure, 100 lb.

Also, does an increase in boiler pressure, say 25 to 50 lb., increase the velocity of the flow of steam?

L. R. R.

A. In the sketch which you send some dimensions are omitted which are rather necessary in order to make computation as to the proper size of crankpin and crank web. You give also the mean effective pressure as 100 lb., whereas the force for which the shaft must be designed is the maximum pressure. Making some assumptions in regard to these figures will make it possible to carry through the computation and you can then make changes if the assumptions are not correct.

To get your mean effective pressure of 100 lb. you are probably using an initial pressure of 170 lb. It is assumed that the diameter of your shaft in the bearings is 2 in. For a center crank design strength has little to do with the dimensions of the crankpin, as



AUTOMOBILE TYPE CRANK SHAFT

any pin which is large enough to carry the rubbing pressure safely will be strong enough to take the load.

Figure first the area required to carry pressure. For a cylinder 5½-in. in diameter the area would be 23.76 sq. in. and this at 170 lb. pressure would give a total of 4035 lb. on the crankpin. For steel shafting at the speed which you will probably run, an allowable pressure is 800 lb. per sq. in. on the projected area, that is, the diameter times the length of the crankpin. To carry 4035 lb. would then require an area 4035÷800=5.04 sq. in. If the pin were made 2 in. long it would be 2½ in. in diameter, or if it is 2½ in. long it should be 2 in. in diameter.

The rule for figuring out a crank and pin, which will be about the dimensions usually used, is as follows: Multiply the horsepower by 0.35 and divide by the strength of the material per square inch. To the quotient add 2.2. This gives the length of the pin.

Assuming that your engine will run at 1500 r.p.m., the horsepower will be $100\times\frac{1}{2}\times23.76\times1500\div33{,}000$, which will give 54 hp. By the above rule the length of the crankpin would then be 0.0019+2.2 or practically 2¼ in.

The diameter is found by multiplying the square of the piston diameter by the steam pressure and by 0.7854 and dividing this by 800 times the length of the pin. In your case this becomes

$$\frac{0.7854\times(5\frac{1}{2})^2\times170}{800\times2\frac{1}{4}}$$

which would equal about 2¼ in. This gives a square pin, as it is called, that is, the diameter is equal to the length, which is frequent custom.

As to the crank web, the thickness is made usually from 0.6 to 0.8 of the shaft diameter. Assuming that your shaft diameter is 2 in. for the size engine you are building, 0.6 would be the usual thickness or, say, 1.2 in., the rule for finding the width is then as follows: Square the diameter of the piston, multiply by the initial pressure and by the length of the crank in inches. Divide this by the thickness of the crank web and by the strength of the material per square inch. The square root of the resultant value is then taken and multiplied by 1.53.

Assuming as before that the strength of the material is 10,000 lb. per square inch, this rule works out the width of the web as about 1¾ in. Evidently this is too narrow for 2-in. shaft of the design that you have indicated, so that the thickness of the web should be reduced. If we make this 1 inch the rule works out to a width of 1.9 in., or, say, 2 in., equal to the width of the shaft. Of course, it may be desirable in view of the design you have in mind, to make the thickness of the web even less, say ¾ of an inch, and let the width come greater in order to give you an extension of the crank beyond the shaft or you can allow a lower stress than 10,000 lb. per sq. in. in your material. The more metal you put in, the greater factor of safety you will have, but, of course, too great a weight in the web will be likely to cause trouble from the unbalancing at a high speed.

Burning Off Economizer Tubes

IN a set of Green economizers, having 320 tubes and carrying a boiler pressure of 170 lb., there is trouble with dampness at the cold end. The tubes have been working about 7 yr. and the bottom ends of the pipes are covered with hard, sooty scale ⅛ to 3-16 in. thick and about 2 ft. high. Some of the scrapers in the middle section will no longer work because of the increase in diameter of the tubes from the formation of this scale, and these scrapers stop a foot from the bottom.

Water enters the economizer at 86 to 96 deg. F. and leaves at 270 deg. I would like to know how to get this scale off as I have been advised to burn the tubes for 15 hr. with pipes empty and scrapers working. How often should they be burned and would it have a bad effect on the metal?

A. Referred to the Green Fuel Economizer Co., this question was answered as follows: "The cause of the dampness at the cold end of the economizer is no doubt due to condensation of the gases where it strikes the cold pipe. As a general rule 90 deg. is sufficiently high temperature at which to pump water into the economizer but in this case it is possible that the temperature occasionally goes below that, or there may be excessive moisture in the gases, which would make it desirable to raise the temperature of the feed water a little more before sending it to the economizer. This could be accomplished by connecting a small pipe between the hot end of the economizer and the suction side of the pump, thus allowing a small portion of the hot water to recirculate and thus raise the temperature of the entering water.

"In regard to removal of scale, 15 hr. is entirely unnecessary to burn the pipes empty and is inadvisable. A period of 3 or 4 hr. should be sufficient to loosen this scale. The rise in temperature of feed water from 90 to 270 deg. indicates that the economizer is giving excellent results."

Kind of Motor

IS a 60-cycle, 110-volt, 2-phase motor better and more economical than a 25-cycle, 440-volt, 3-phase motor for running a conveyor from boats to a warehouse for unloading, about 3 or 4 hp. capacity is required? The 60-cycle, 110-volt, 2-phase circuit is already wired in the warehouse, but the 25-cycle, 440-volt circuit is not.

R. E. K.

A. The 440-volt, 3-phase, 25-cycle motor will be better. In the first place, a 3-phase motor is a steadier running motor than a 2-phase, the 440-volt machine will be more economical than the 110-volt, and the 25-cycle will be more economical than the 60-cycle. Of course, if you run this motor only a small part of the time, it may be that for a 3 or 4-hp. motor it would not pay you to change the wiring, as you already have this in place for the 110-volt motor.

Questions for First Class License

ABOUT how many gallons of water are required to supply injection water to a condenser for a 150-hp. engine? What is the rule?

2. Suppose you had a boiler 60 in. in diameter, thickness of plate ¾ in., tensile strength 55,000 lb., shearing strength of rivets 42,000 lb., and double riveted lap joint. How would you determine the pitch of rivets so that the strength of net section will be equal to the shearing strength of rivets?

3. How do you put a nipple in a B. & W. boiler?

4. How do you figure out the receiver pressure for a compound engine?

5. Is there any objection to the use of 3-ring packing on a piston?

6. If you were given the number of pounds of coal burned per hour by a certain boiler could you figure out the size of safety valve required?

7. Suppose you were chief engineer of a plant about to install new boilers and the manufacturers stated that they could furnish plates with a tensile strength of 75,000 or 80,000 lb. per square inch, what objection would you give if they also stated that the plates were extremely homogeneous? What reason would you give for not using plates having a low tensile strength, say 30,000 lb.?

8. If the connecting rod on the engine should break how would you get the correct length of it?

A. E. B.

A. In the absence of any information as to what kind of engine you are running, we assume 20 lb. of steam per horsepower-hour, which would mean that your engine would use 3000 lb. of steam an hour and for a surface condenser this would require in the region of 40 lb. of cooling water per pound of steam, or 120,000 lb. per hour. This would be 14,400 gal.

2. You do not give the diameter of rivets to be used, but in a ¾-in. plate the rivets will be 1⅛ in. diameter. The area of the rivet will then be 0.994 sq. in., and the shearing strength of a rivet will be 42,000×0.994, or 41,770 lb. The area of plate between 2 rivets should equal in strength the shearing of 2 rivets so that the strength of a section should be 83,400. At a tensile strength of 55,000 lb. per square inch this will require an area of 1515 sq. in. of plate between rivets. At ¾-in. thick, this calls for a distance of 2.02 in. between the rivet holes, and adding the diameter of the rivet hole, which for a 1⅛-in. rivet gives a pitch on centers of the rivets of 3.2075, which would be made 3 3-16 in practice.

3. We assume that you mean the short tube connecting a header to the steam drum. These tubes are expanded into bored holes. For expanding into the header it would be necessary to use an expanding beading tool which would slip through the tube and then be expanded by a screw wedge, or an expander working on the same principle might be used. The upper end of the tube which connects into the steam header would be expanded the same as any boiler tube, by an expander working in the end.

4. The receiver pressure for a compound engine depends on the cutoff of the low-pressure cylinder and the ratio of cylinder volumes. If cutoff is at the same point in both cylinders the receiver pressure, pounds absolute, will equal the initial pressure pounds absolute, divided by the ratio of cylinder volumes. If the cutoffs are not the same, the initial pressure must be divided by the ratio of cylinder volumes times the ratio of cutoffs. For instance, if the ratio of cylinder volumes is 4.5, cutoff in the high-pressure is at 1-3 and the cutoff in the low-pressure at ¼, and the ratio of cutoffs will be ¼÷1-3, or ¾. Multiplying this by 4.5 gives 3.36, and if the initial pressure be 140 lb. the receiver pressure will be 140÷3.36 or 41.5 absolute, which is 26.5 lb. gage.

5. The only objection to using 3-ring packing in a piston is that it is more complicated packing to take care of than the 2-ring, also if the packing rings be made of the same width it will involve a longer piston, which means a longer cylinder and more expensive engine. If the width of the 3 rings is made equal to 2 rings it means narrower rings, which are more likely to twist sideways and also to wear more rapidly.

6. If you knew the number of pounds of coal burned per hour by a boiler, the kind of boiler and the pressure at which it was run, you could figure very closely the size safety valve needed. The valve must have a capacity large enough to carry off all the steam the boiler can make and if you knew the boiler was of a type which would evaporate under ordinary conditions 8 lb. of water per pound of coal, you could find the total steam made per hour and from the pressure and the steam tables you could find the number of cubic feet which this would give. Then taking a table of safety valve areas and lifts you could decide what size valve would be needed to carry this away at the usual rate of flow per minute, which is 6000 ft. a minute.

7. A plate of tensile strength of 75,000 to 80,000 lb. would, as a rule, be low in elongation, that is, it has so much carbon that it is not sufficiently elastic. It is likely to crystalize or to be brittle. A plate with a tensile strength of only 30,000 lb. would be a low quality of steel, likely to have defects in it, also if it were sufficiently uniform to be safe to use, it would require a very thick plate to carry common working pressures and this thickness makes it difficult to work and also more likely to flaws than a thinner plate. A plate of 80,000 lb. tensile strength with great homogeneity would indicate steel which had been carried too far in the making so that the carbon had been increased beyond the desirable amount.

8. The length of a connecting rod could be found by finding the striking points for the piston and measuring the distance between crosshead positions at these striking points, then take twice the length of the crank, to give the stroke of the engine. The distance between this and the distance between striking points gives the double clearance and when this is halved the piston can be set at the right position from one striking point. The crank should then be set on the corresponding dead center and the distance between the crank center and the center of the crosshead pin will be the length of the connecting rod.

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A CONTRAST

A sight that rejoiced the heart was that plant. Yet it had only one 75-hp. Corliss engine, crop of about 1875, two belted 2 pole dynamos, born in 1880, or thereabouts, two tubular boilers with architectural cast iron fronts of the fashion "befo' de war," and a wheezy feed pump. But it was clean—engine and boiler room, the machinery was free from oil and dirt. There was a modern feed heater, an improvised wash room, a fan sending air into a closed ash pit and Illinois coal was being burned without smoke.

One man ran the whole plant and wheeled his coal from an outside shed, yet he kept his boiler room swept and engine room scrubbed. He was a real engineer who rejoiced in getting the most out of a meager outfit.

The contrast—was not far away, and it had a 500 hp. engine of the latest type, not over four months in service, and the engineer (?) had only engine, pump and dynamos to look after. But how she rattled and banged! There was some brass but no "bright work" in that plant—belts, pulleys, rods, frame—all well coated with dirt and oil; grease and water on the floor. It was pitiful to see a faithful servant so ill-treated as was that installation.

And the man in the little plant gave a cheery welcome, and the man in the big plant grumbled at his hard luck. Why?

VALUE OF EXAMINATION QUESTIONS

Why are lists of questions popular? Of course they train for passing examinations; but there are comparatively few states and cities where examination is required, yet they are one of the most popular forms of instruction.

The answer is, they test your knowledge—give a standard by which to measure what has been learned. That's one way.

But answering questions that come easy is little help in growing. It's the hard ones, where you have to hunt for the answers that are profitable. When you have dug out the why and the how, you have got something you didn't have before.

The way to make those questions help, then, is to skip the easy ones and tackle the hard ones, not the opposite. If you can't find the answers—try again. Don't let any little ordinary set of printed words make you say "I don't know," or "I can't tell that."

BANG!!

This is the conventional sign for a noise such as our conventional Fourth of July has brought with it. Results—wasted explosives, shattered nerves, burned homes and buildings, damaged and dead children, broken hearts. A boiler or flywheel explosion which maims and kills is decried as criminal. Isn't it as much a duty to begin your plans for a safe Fourth celebration for your and your neighbor's children, as it is to keep the safety valve and the governor in safe operating condition? We're all men with a duty to family and society, as well as to the profession.

POWER PLANT BETTERMENT*

By H. H. Hunt†

IN this paper is undertaken a brief discussion of some of the problems which arise in the work of power plant betterment, by which term is meant improvement in economy of operation and maintenance.

Careful and detailed examination by an expert in power station operation will often reveal many features which are capable of marked improvement, resulting in recommendations which, if properly carried out, will result in reductions in costs of manufacture and maintenance, and all this without the expenditure of a large amount of money for revamping the plant.

Persistent Work Needed

IT has just been said, that the improvements will follow if the recommendations are "properly carried into effect." This is a most important point to be borne in mind in any attempt to increase the economy of a power plant. It is a simple matter to employ a competent expert, allow him to make such examination and tests as to calculate possible savings, make detailed recommendations and give instructions as to how the possible savings may be secured.

If the betterment work stops here, little will be accomplished. It will be necessary to retain the expert for a sufficient length of time to enable him, by detailed attention to the actual operation of the plant, under regular working conditions, not only to demonstrate the correctness of his recommendations, but also to instruct the power plant organization, so that they can continue the work.

Study of Men

IN undertaking the betterment of operating conditions in a power plant, attention should first be given to the personnel of the operating force. Desired results cannot be obtained by incompetent men. It goes without saying that the chief engineer, who must be primarily responsible for what takes place in the plant, should be a man of both operating and executive ability, capable of enforcing strict discipline. He must be capable of receiving instruction, as must also, the other members of the force. Each man who does not possess the possibility of becoming a thoroughly efficient and alert member of the force, should be replaced as soon as possible.

Most careful study will be required in arriving at correct conclusions in reference to each individual of the operating force in order that justice may be done. Not infrequently it happens that certain men develop unexpected ability as they gradually become familiar with the methods by which actual improvements are brought about. Furthermore, every reasonable opportunity should be given present employes to measure up to the new requirements in order to avoid the needless discharge of men. Under the improved conditions, in place of indifference and lack of ambition should be found alertness, efficiency and a greatly increased interest in the work, all of which are necessary to success.

Fixing Up

THOROUGH physical examination of the plant should be made and immediate steps taken to correct such defects as can be remedied without excessive cost. Starting in the fire room, for instance, boilers will be thoroughly overhauled and cleaned, leaky tubes replaced, blowoff cocks and valves made tight, gage glasses and dampers put in order, air leaks in boiler settings stopped, furnace linings, bridge walls and grate bars put in order, safety valves adjusted and steam gages calibrated.

The work will continue in like manner to the engines, paying particular attention to valve setting, steam piping, pumps, condensers, heaters, oiling system and electrical machinery, apparatus and wiring and all other parts of the plant.

In connection with this general overhaul of the machinery, all gages, meters and measuring instruments should be calibrated and tested, so as to give accurate information regarding the operation of the plant.

Attention should also be given to the matter of tools, and it should be seen that a suitable assortment is provided, both for the engine room and the fire room.

Finally, the station should be thoroughly cleaned and all housekeeping matters given proper attention, for while, theoretically, there may be no connection between cleanliness and economy, a dirty, ill-kept plant indicates inefficiency.

With the physical plant in good working condition and the power plant crew in an alert and receptive mood, the details of operation may now be taken up.

Feeding the Boiler

ALL firemen will be individually instructed in the handling of the particular coal in use; the use of properly designed fire tools; the proper operation of the dampers and proper control of the draft. A thorough course of training should be given along these lines, and further, the chief and watch engineers should know every detail of the proper handling of the fires in order that they may be able to maintain intelligent oversight of the fire room.

Special attention will be given to the maintenance of boiler pressure and temperature of feed water, in order to avoid the usual fluctuations which so largely affect station economy. Recording pressure gages and feed water thermometer and a bulletin board in the fire room, on which are posted the coal consumption and pressure records of each watch, will serve a useful purpose in arousing enthusiasm.

An operating engineer can profitably spend a good portion of his time in intelligent personal supervision of the fire room operations.

Operating Schedule

ATTENTION of the expert should be carefully directed to the engine room. It is of importance to provide operating schedules so that the varying conditions of load may be met by the economical use of apparatus; in other words, so as to avoid the use of 3 boilers when 2 are sufficient, and so on. A most careful study of the load conditions will be made and charts prepared which will show clearly just what combinations of apparatus and machinery should be used to meet the various conditions of load, the idea being so to arrange the schedules that each piece of apparatus, when in use, will be operated as nearly as possible at its point of maximum efficiency.

*Presented before the Congress of Technology at the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

A carefully designed station log will also be provided which will contain the daily operating data of the plant recorded in a systematic manner. In such a station log it is desirable that the main facts, such as coal consumed per kilowatt-hour, water evaporated per pound of coal, etc., be shown so clearly that the manager of the company, by spending a few minutes daily in the study of the station log, may fully acquaint himself with the daily operations of his plant and be in position to discuss matters intelligently with his chief engineer.

(To be continued)

ILLINOIS ENGINEERS' CONVENTION

OTTAWA, MAY 19-20—A LARGE EXHIBIT—LECTURE ON COMPLETE COMBUSTION, PRACTICAL EDUCTION AND WATER ANALYSIS

AS the first performance of the year by the Central States Exhibitors' Association and the first State Convention for 1911, the meeting gave bright promise for the coming meetings of the season.

At the opening on Friday, there were the usual addresses of welcome and congratulation which serve to start every convention with an atmosphere of good feeling.

In the course of one of these, Mr. Wm. H. Miller of the Free Trader, referred to an interesting historical fact in the fuel problem. It was on almost the exact spot where the Armory now stands in which the exhibit and meetings were held that Illinois coal was first discovered and burned by trappers throwing a "black rock" into the camp fire which "ignited and gave off a great heat." This took place nearly 300 years ago, and 150 years before Watt's improvement of the steam engine.

Objects and methods of the association were, as usual, discussed, the speakers being Mr. J. C. Daley, Mayor Bradford, President W. L. Parker, Secretary Raven and J. W. Lane. Mr. Lane made a worth while suggestion which was later acted upon by the association, that the University of Illinois be requested to arrange an annual meeting at which those interested in power plant operation shall be put in touch with the work that the Experimental Station and the University are doing bearing on this branch of work.

Secretary E. P. Gould of the Exhibitors' Association explained clearly the relation of the exhibits to the association business, showing that it is a part of the business of the engineer in his own and his employer's interest to keep informed of new developments in machinery and accessories and study their value as applied to his own plant.

Complete Combustion

AT the afternoon session, Prof. K. A. Smith of the University of Wisconsin, explained the conditions of perfect combustion, illustrating the effect of too little air, too much fuel, poor draft, and cooling of flames in producing smoke by means of the familiar action of a kerosene lamp.

Special points mentioned were the German practice for forcing a boiler with a chain grate stoker by adding a flat grate at the end of the chain stoker and discharging the unburned fuel upon that grate to complete combustion. This grate can also be separately fired.

Another method for handling a coal like our lignites which is high in volatile and slag is to combine a grinder and blower so that the powdered fuel is discharged at the middle of the furnace vertically upwards. In this way, the heavier particles are carried higher than the lighter ones, thus giving them more time to burn before reaching the furnace floor, also the slag particles, thrown farthest, reach the sides of the furnace and rolling down are cooled and left as marbles, instead of in a compact mass.

Report of the educational committee gave the prize for the best work of the year to Peoria, No. 6, on an average og 94.3 per cent, the blackboard being received by Past President Randles for the Peoria Association.

Practical Education

SPEAKING Saturday morning on this subject, Prof. W. F. Mozier of Ottawa defined the objects of edusation as fitting a person to live and to make a living.

He emphasized the need of the high school for the protection of the child and of the community as it keeps the child under proper influence during the most important formative period of his life and at the same time protects the community from having him turned loose while immature, as a supposedly responsible member of society and also protects it economically from the use of inefficient workers for the sake of low wages.

Water Analysis

FOLLOWING this was a lecture by W. A. Converse, Chemical Director of the Dearborn Drug & Chemical Works, on the subject of "Water, what it Contains and Why it Causes Trouble." He told of the gases dissolved from the air by water when it falls as rain; how these affect the amount of mineral matters taken up from the soil, such as silica, iron and aluminum oxides, carbonates and sulphates, and gave illustrations of the common forms of each of these minerals. Iron oxide would be known as rust, aluminum oxide chiefly in clay, giving its characteristic gray color. Calcium carbonates we know as whiting and school crayons; calcium sulphates as plaster paris; the magnesium chlorides and oxides as white chalky substance, magnesium silicate as soapstone, or as isinglass; magnesium sulphate as epsom salts, sodium compound as common salts and glaubers salts.

Mr. Converse illustrated also the effect of certain kinds of minerals in water, as for instance, a water containing a large percentage of sulphates and carbonates, even though not enough to form a hard scale might cause trouble by dissolving asbestos from asbestos gaskets and softening the rubber in a rubber sheet gasket because of the excessive alkalinity. A water containing a large amount of sulphate may cause corrosion underneath the scale by freeing of sulphuric acid from the sulphates in the scale.

He spoke also of the fact that water may be too pure as in the case of rain water or distilled water, and may, therefore, take up iron from the boiler plates, causing pitting and corrosion. He showed analyses of water taken from the same river at different times and emphasized the need where such water is used of having frequent analyses made in order to keep track of just what impurities are in the water.

The speaking of the morning was closed by a brief talk from Ex-Mayor J. F. Farrell, after which election of officers was held, resulting in the choice of John Alt, of Ottawa, president; J. R. Moore, Chicago No. 1, vice-president; W. E. Hill, of Moline, re-elected as secretary-treasurer.

Exhibitors

DURING the intermissions and on Friday evening the exhibits in the main hall of the Armory attracted much attention. They included several novelties as well as old staple lines with which the visitors at the convention had become familiar through frequent presentation.

THE DEARBORN DRUG & CHEMICAL WORKS made no exhibit of its product, but furnished amusement with the efforts of delegates to get a light from the drugged matches which were of the safety variety with a vengeance. Representatives present were W. A. Converse, chemical director; O. E. Poole, A. C. Cooke, F. C. Gibbs, E. P. Poole.

FOR THE G. M. DAVIS REGULATOR CO. the booth was decorated with flowers by the representative, M. D. Neely. An attractive arrangement of catalogs of the Davis steam specialties was made.

V. D. ANDERSON CO., of Cleveland, presented literature on its oil filters and traps and showed also sections of the Model D Anderson steam strap, illustrating the construction of the removable valve. I. P. Lounsbury, of Chicago, and his assistant, Bruce Lounsbury, were in charge of the booth.

L. A. KENNEDY represented the Sullivan Oil Co., of Chicago.

R. H. RAWSON showed for the McMaster-Carr Supply Co. a line of the steam specialties which it handles.

FOR THE CRANDALL PACKING CO. there were presented by the representatives, W. F. Ebert and F. M. Wheeler, a full line of fibrous packings showing samples of flax rings, square and cushion packing and of the gasket and sheet. A new metallic packing was also shown. The C-B steam trap was also illustrated by model and descriptive literature.

THE JOHNS-MANVILLE specialties include so many different lines that it is impossible to list or describe them all. The principal departments covered are the asbestos and rubber packings, pipe coverings of air cell, asbestos and magnesia types, cork insulation for refrigerating plants, and the electrical specialties including enclosed fuses and Lin-o-lite for showcase lighting. The company's representative, Joseph Campbell, gave on Friday evening a special talk to business men on the use of the Lin-o-lite for lighting displays in show windows.

JENKINS BROS. showed samples of the famous Jenkins valves and pump disks, the old familiar '96 sheet packing and tubular gaskets and a new brand of sheet packing for general purposes known as the Overland. H. D. McClelland was in charge of the company's interests.

FOR THE HAWKEYE BOILER COMPOUND CO. the representatives were H. E. Tibbles and Theo. Brommenschenkel.

THE GARLOCK PACKING CO., represented by Al F. Mayer, of the Chicago office, showed samples of round and square packing, wedge and cushion for difficult cases and the No. 900 gasket and sheets.

H. BANZENMACHER acted as special representative for the General Specialty Co., showing its whole line of boiler cleaners, also the Kelley rocking, dumping and stationary grates.

PEERLESS RUBBER CO.'s product, including full line of mechanical rubber goods, was illustrated by C. A. Elliott, of Geo. B. Carpenter & Co., Chicago. The booth was made particularly attractive by the use of gladiolas and the decoration in Japanese parasols.

FOR THE LUNKENHEIMER CO. E. F. Bowles, manager of the Chicago office, E. P. Gould, secretary of the Central States Exhibitors' Association, and C. C. Rodenberg entertained visitors. The display consisted of valves, oilers, brass specialties for steam and gasoline engines, and the hospitality of the company was extended in the presentation of flowers to each visitor at the booth.

MR. TOWNSEND arranged an attractive display for the Geo. W. Lord Co., showing successes that have been achieved in increasing the efficiency of boiler plants by the use of the Lord boiler compounds which are prepared and shipped in dry form.

A. S. BENNETT, of the Keystone Lubricating Co., emphasized the attractive offers which his company was making to engineers on trial orders for its product.

HILLS-MCCANNA CO., of Chicago, represented by W. E. Hills, showed its force feed lubricating pumps, high-pressure gage cocks, low-water alarms, sight feeds for indicating the rate of flow of oil in a lubricating system and O'Connell swing joints.

THE ACTION OF THE Lyons boiler was illustrated by Working model under the charge of W. P. Lyons.

ENGINEERS AND FRIENDS AT ILLINOIS STATE CONVENTION

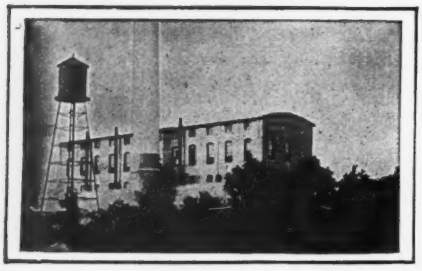
PALMETTO AND MANHATTAN packings for steam and hydraulic systems were displayed by F. E. Ransley, Chicago representative of Greene, Tweed & Co., and by his assistant, G. A. Hawkins.

A COMBINATION EXHIBIT OF THE American Steam Pump Co. and the Scott Valve Co. included a section model of the Marsh steam pump showing the valve action and the construction of steam and water pistons, also descriptive matter illustrating the American and Marsh air compressors, the Peters Corliss valve trap, the Triumph oil separator and the construction of Scott valves for steam and water. Everett A. Evers acted as representative for the American Steam Pump Co. and C. M. O'Brien for the Scott Valve Co.

SPECIAL CONSTRUCTION of valves and fittings for piping systems as manufactured by the Osborne Joint & Valve Co. was shown at its booth by W. L. Osborne, the inventor, and C. M. Schneider. The exhibit was arranged as an attractive triangle consisting of different sizes of valves and fittings.

CENTRALINE OILS and greases were displayed in grades suitable for different purposes by R. L. Davenport, of the Galesburg office.

OTHER COMPANIES HAVING representatives at the convention were: The John A. Roebling's Sons Co., represented by J. H. Wilson; National Engineer, represented by Robert Larkin and John W. Lane; Power, by Osborn Monnett; Harrisburg Foundry & Machine Works, by F. W. Jackson; Practical Engineer, by Arthur L. Rice.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

SHOP AND POWER HOUSE VENTILATION

DURING the last few years the matter of ventilating shops and power houses has been given much attention by architects and consulting engineers engaged in work on such buildings. This came about because it became recognized by those who gave attention to the subject that an abundant supply of fresh air is necessary to health and also that sufficient ventilation and good lighting in buildings where many men are employed contributes to getting the best results in the way of work, both as to quantity and quality. It is of the greatest importance, therefore, for both monetary and sanitary reasons that all buildings should be given the best possible equipment for ventilation and for lighting, both daylight and artificial. Fresh air is cheap and may be obtained in practically unlimited quantity almost without cost at but slight additional expense when erecting new buildings, provided arrangements for ample ventilation are made. This means simply a method of producing circulation.

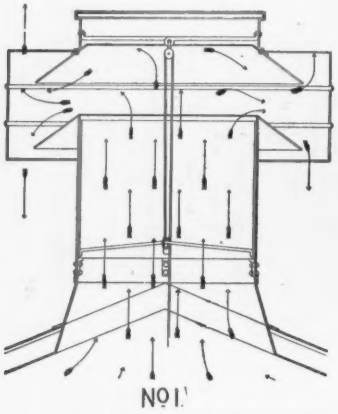


FIG. 1. SECTION OF BURT VENTILATOR SHOWING FLOW OF AIR

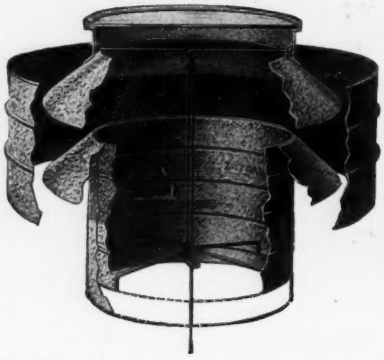


FIG. 2. SECTIONAL VIEW OF GLASS TOP VENTILATOR SHOWING CONSTRUCTION

FIG. 3. THE BURT METAL TOP VENTILATOR

In most cases the use of fans or blowers is not involved for ventilation alone, as sufficient air movement can be secured in one-story buildings by providing a direct ventilator for escape of the heated air next to the ceiling or roof.

Notwithstanding this simplicity, comparatively few shops are found which are adequately supplied with fresh air. This brings up the question. What is an adequate air supply? And it is found by scientific authorities that 200 cu. ft. of fresh air an hour for each person is about the minimum quantity which must be introduced to prevent ill effects from the vitiated air. If smoke or gases are mixed with the air of a work-room, from 400 to 600 cu. ft. an hour should be supplied for each person, and for each gas jet or other open flame an additional 40 cu. ft. an hour is required; thus in a room containing 20 workmen, each provided with a gas jet to light his work, the minimum supply would be 4800 cu. ft. of fresh air an hour, and if this were a machine shop where much oil is used and more or less dust constantly rising, at least twice this quantity is desirable.

In order that proper temperature may be maintained, both inlet and outlet of air should be adjustable and under perfect control so that maximum circulation can be secured without lowering the temperature below the point desired. Even where heating and ventilating apparatus is installed, many shops have no provision for letting out the foul air. This frequently results in producing drowsiness among the workmen, which has a marked effect on activity.

That means are not provided for carrying away the impure air is usually because managers and plant owners do not realize the difference in productiveness between workmen in a well ventilated and comfortably warm shop and those in a cold shop filled with foul air. Systems for heating and introducing fresh air are adequately considered in most of the books on heating and ventilation and in some cases exhaust fans are introduced and occasionally are necessary in order to remove the impure air, but such costly investment is usually entirely unnecessary.

Foul air is naturally warm and will rise toward the ceiling or roof, and good ventilation can be secured merely by providing a suitable outlet for the foul air in the ceiling or roof, so arranged that the daylight can be controlled. Fresh air may be admitted at various points in or near the floor and with openings for foul air to escape from the roof the air in the building will be kept in motion at a velocity so low as to produce no perceptible draft, yet sufficiently high to supply the fresh air needed.

One apparatus for producing such ventilation is the Burt ventilator, which is so constructed that when

its operation is most needed, viz., during perfectly calm weather, it will be effective in drawing impure air from the interior of the building. The design is as shown in the illustration and is such as to prevent its becoming clogged with snow or ice and also to prevent any back current of air. It is a stationary ventilator, therefore, does not have mechanism to get out of order.

An important characteristic is that the Burt ventilator may be provided with a glass top in which case it acts as both skylight and ventilator, thus usually making unnecessary any other form of skylight. In weather when it is desired to close the ventilator this may be done without in the slightest degree obstructing the passage of daylight through it. This is accomplished by means of a special damper which leaves the air shaft always free and unobstructed, whether the ventilator is closed or open.

As shown in the cross section, the air current flows unobstructed to the top of the air shaft, where it escapes from the ventilator, and as the current of air does not tend to move the damper in any way, it always stays in the position where it is set. When it is drawn clear up the ventilator is closed. When it is lowered the ventilator is wide open.

When a glass top is used it is made of heavy wire plate set in a groove and made absolutely water-tight by using waterproof cement so that it cannot leak. A trough is provided below the glass top and into this any condensed water which may gather on the glass runs and passes through small holes to the outside of the ventilator. A trough is also placed on the lower part of the bases to collect all condensation which might possibly form on the air shaft, but this is hardly necessary as it is seldom that a ventilator will sweat on the inside.

When glass top is ordered a special design of band is used, so that the glass can be shipped separately and put in position by any good workman, or if the glass gets broken in any way a new one can be put in without taking down the ventilator. The patented damper, which consists of a sliding sleeve, is operated from below by means of cord and pulley and each ventilator is fitted with special attachment so that the damper may be adjusted in any position and held permanently without fastening with a cord and nail or counterbalancing the damper.

In the power plant a ventilator is of special importance on the power house, which often is dark and dingy and if unventilated has the air usually saturated with gases and fine particles of coal dust. Equipment of the boiler house roof with Burt ventilators assists in giving light and thorough ventilation, and also in warm weather, when the temperature is likely to be excessive, use of the Burt ventilator will greatly modify the temperature of the room. This ventilator is made by the Burt Mfg. Co., 204 Main St., Akron, Ohio.

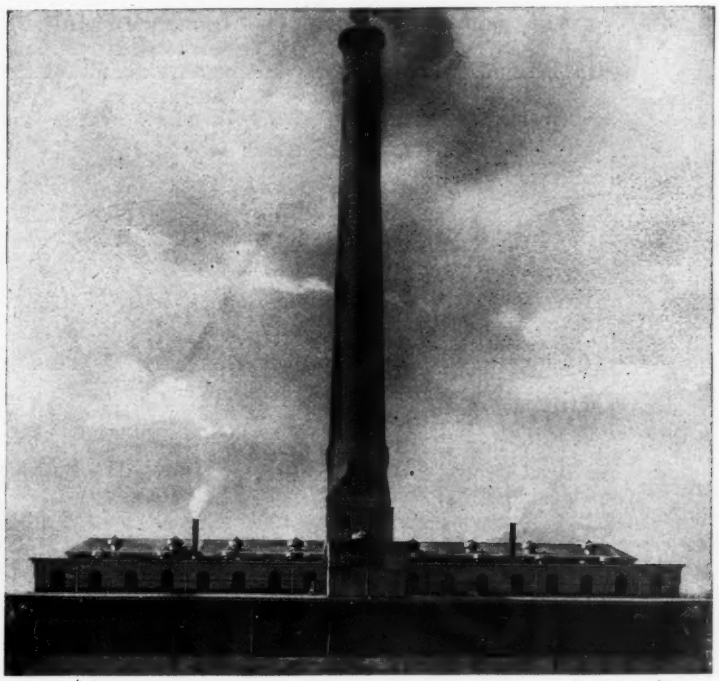


FIG. 4. POWER PLANT OF AURORA, ELGIN AND CHICAGO R. R. AT BATAVIA, ILL.

IMPROVED COOKSON HEATER

ORDINARILY the oil separator of an open heater purifies only enough exhaust steam for heating the feed water, while if the interior of the heating system is to be kept from fouling, or the condensation from a hot well or receiver is to be re-used, an additional separator must be installed in the line. The new Cookson cast-iron heater shown herewith has an oil separator big enough to purify all the exhaust steam from all boilers or engines of the greatest capacity which the heater can serve.

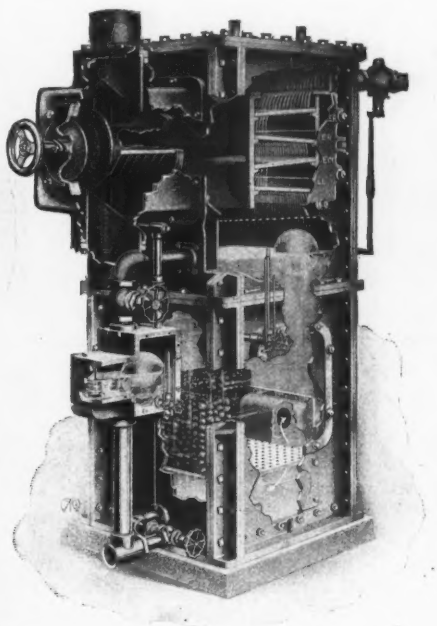


FIG. 1. INTERIOR VIEW OF COOKSON HEATER AND RECEIVER WITH CUT-OUT OIL SEPARATOR

This heater is made with a cutoff valve within the separator to permit the heater to be cut out for cleaning without interfering with the functions of the oil separator, and has exhaust inlet and outlet connec-

tions in a direct line to permit the heater to be inserted in a vertical exhaust line without disturbing the pipe except to remove a short length to admit the separator.

Separation is accomplished in the new Cookson heater by change of direction of the current and expansion as follows:

Exhaust steam enters the separator from the bottom and leaves through the outlet at the top. As the steam leaves the engine exhaust pipe, it passes first through a tube projecting inwardly on the inlet flange and cut to open on an angle opposite the opening on the heater inlet tube.

Steam is then divided by a V-shaped ribbed baffle cast on the under part of the heater inlet tube, which deflects the current to the separator walls. The steam currents, therefore, make nearly a right angle and must travel back again before they reach the exhaust outlet or the inlet tubes to the steam chamber of the heater.

Meantime the oil and water particles, due to their greater weight, are dashed against the separator walls, which are ribbed their full length and breadth. Oil and water carried down these ribs fall into a well formed around the exhaust inlet tube, but out of the steam current. This well drains through a balanced float trap (or water seal, if there is no pressure within the heater to require the use of a trap) and empties into the heater overflow pipe.

All steam not going to the heater passes through a tube on the outlet flange similar to that on the inlet flange, but sloping downward and with angle opening

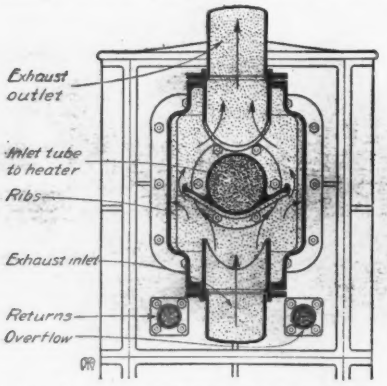


FIG. 2. END SECTION OF SEPARATOR

cut in the opposite direction to that on the inlet, thus compelling the steam to travel in opposite direction to that in which it entered.

Steam for the heater passes through the central horizontal tube, which is faced on the outer end to form a tight seat for a valve actuated from the outside of the separator. This valve may be opened or closed at will to regulate the inflow to the heater.

The overflow cut-out is merely a standard globe valve, while the separator cut-out is practically the same.

Cold water comes in near the top of the heater to a spray box, which is notched on the edge to spread the water in small streams onto the top tray and successively in a thin layer over the other trays and into the reservoir. A balanced valve in the water line operated by a copper float on the water level, regulates the flow of cold water. The trays are readily removed through the upper door when the deposit of coarser impurities renders cleaning advisable.

Gases liberated in heating go to the top of the heating chamber, from which a vent permits them to escape to atmosphere or into the exhaust outlet.

Water is prevented from rising above a desirable level and provision is made for skimming the reservoir surface by an overflow plate that extends horizontally across the heater and drains an even sheet of water into the overflow pipe. The difference between normal and overflow levels is sufficient to take care of any sudden large discharge of water into the heater as from steam traps, or slugs from the heating lines.

Removal of any oil or other impurities floating on the water surface is accomplished by merely holding the cold water valve open until the reservoir level goes above the overflow line.

Suspended impurities which are too heavy to float are removed by the filter bed. The filtering material, usually coke, is supported by a removable perforated cast-iron plate, which prevents any from getting to the lower or settling chamber. This lower chamber has at the bottom 2 flat surfaces sloping to a common gutter at the center. Any minute particles that pass through the filter naturally fall toward this gutter and are removed by opening the blowoff valve.

The Cookson Heater is made by the Bates Machine Co., of Joliet, Ill.

JEFFERSON UNION ELBOWS

UNIONS and elbows combined, built with the strong features of their straight and swing unions, have been put on the market recently by the Jefferson Union Co., of Lexington, Mass. These new union elbows are made both all-female, and male-and-female; and the advantages of using them whenever a union is needed near an elbow will be evident at a glance, as they save labor, expense and gaskets.

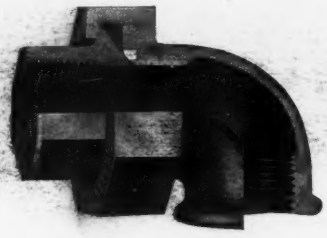


FIG. 1. ALL FEMALE JEFFERSON ELBOW AND UNION

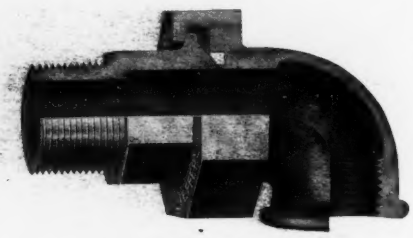


FIG. 2. JEFFERSON MALE AND FEMALE UNION AND ELBOW

The all-female elbow takes the place of 2 pipe-joints that are somewhat troublesome to make, and 3 ordinary fittings—first, a straight union, second, a nipple; and third, an ordinary elbow. Results are better when there are fewer joints as there are just so many less chances for leakage.

The male-and-female elbow saves 3 pipe-joints, and takes the place, first, of a straight union; second, of 2 nipples; and third, of an elbow. The joints avoided by this combination are even more difficult to make than those for which the all-female elbow is a substitute.

Absolutely precise aligning of the elbow and pipe on the 2 sides of the elbow, no matter which style of union is used, is not required, because of the construction of the Jefferson. This has the ground spherical brass-to-iron joint, which avoids corrosion, and the use of a gasket. In addition, there is a large amount

of play between the nut of the union and the swivel end, making the union very easy to apply even when the alignment is not exact.

Construction of the nut, and its adjustment to the swivel and the brass seat ring, are special features. The brass ring is turned from seamless brass tubing, and therefore always free from blow holes and imperfections. In the second place, the ring sets in a recess away from the runway of the pipe, with an iron wall on each side, and is thus secured against any possible loosening on account of the difference in the expansion and contraction of the iron and brass.

The pipe ends are made of malleable iron, which will not stretch, and are threaded with Briggs standard taper pipe threads, to insure a tight joint throughout the length of the thread. The nut threads are coarse enough to allow of rapid adjustment, and as they are coated with graphite, both for lubrication and to prevent their corrosion, the union may always be easily disconnected after it has been in use. The nut of the Jefferson Union is always marked with the name "Jefferson," and with the size. The Jefferson Union Co. is prepared to furnish both 90 deg. and 45 deg. unions.

VICTOR GASKETS

THESE are of the metal enclosed type consisting of a copper shell made of pure Lake Superior copper spun round a cushion of high grade imported asbestos or of rubber sheet, as may be desired. The gaskets are made in round form, having copper on both inside and outside edges of the cushion and also in the French type, having the copper in U section, with the asbestos between the legs of the U. For

FIG. 1. THE VICTOR ENCLOSED GASKET

FIG. 2. VICTOR OPEN EDGE FRENCH TYPE GASKET

low pressure and ordinary work a single jacket is used, for high pressure and extreme service a double jacket.

A specialty of the makers, the Victor Mfg. & Gasket Co., of Chicago, are water-tube boiler gaskets for the tube plate joints. These are made of copper and rubber, copper and asbestos, or copper and lead, for all the different standard makes of water-tube boilers; also gaskets for all purposes and general use for locomotives, railroad plants, automobiles and motor builders.

VENTURA VENTILATING FAN

FOR about 4 years The American Blower Co., Detroit, Michigan, has been developing a new curved blade disk fan, and has obtained some high mechanical efficiencies. This new fan is called the Ventura. It has 10 broad blades of the proper dip or curve to move large volumes freely or against pressures and so efficiently that the power consumption is low. Patents on the constructional features have been applied for.

The Ventura fan runs at any speed necessary and throws an air current straight ahead. In fact, the air as it leaves the fan has a tendency to bend inward for a considerable distance before it begins to expand. To illustrate this feature—one of these fans can be set 16 in. away from a hole in a box and discharge more air on the other side of the opening than the fan itself handles, due to the siphon action of the air as it passes through the opening drawing in air along the face of the box.

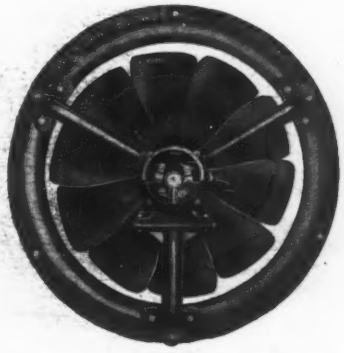


FIG. 1. VENTURA DISK FAN AS INSTALLED

The accompanying chart shows the relative capacity and mechanical efficiency of the new Ventura as compared with 2 of the best known makes of propeller type fans.

Curves No. 1 are for the Ventura fan. Curves Nos. 2 and 3 are of the competition fans above mentioned,

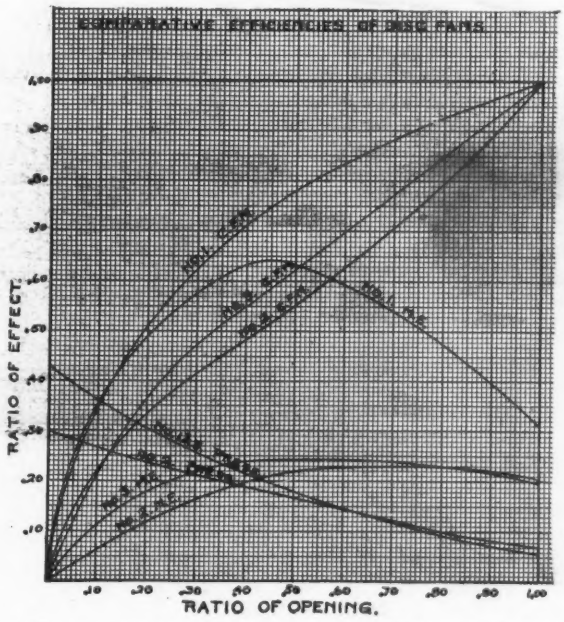


FIG. 2. CURVES OF COMPARATIVE PERFORMANCE OF DISK FANS

and were plotted from exhaustive tests under like conditions.

Particular attention is called to the mechanical efficiency of Ventura fans, which runs as high as 64 per cent.

MAPLE LEAF III., the new hydroplane launch designed by Thomycroft, has attained a speed of 60 miles an hour in trial runs.

OUT OF 100 leading products in any line, 99 have become so through advertising.

NEW PLANT OF VICTOR-BALATA TEXTILE BELTING CO.

THIS plant, which has recently been completed at Easton, Pa., is a transference to this country of the manufacture of a style of belting which has long been in use and long been manufactured in Germany. The new company is composed of German and American interests, the secretary and manager of the new plant in Easton being a grandson of the founder of the German company, and the president and treasurer of the new company being men well known in belting circles in America.

The German members of the company are those of the well known belting manufacturers, C. Vollrath & Sohn, Blankenburgh, Germany; the American interest being represented by Messrs. C. E. Aaron and J. R. Stine, respectively the president and secretary-treasurer of the New York Leather Belting Co., New York.

The first buildings which are only a part of the total plant planned for are of steel and concrete construction, giving about 30,000 sq. ft. of floor space. More than 10 acres of land have been acquired, thus allowing ample room for future additions, the power plant for the factory being of modern economical design, housed in a special L extension. It is equipped with the E. Keeler Co., high-pressure water-tube boilers of 200 hp. each and a Hewes & Phillips Corliss engine. Selling will be conducted from 51 Beekman St., New York, and 172 N. Franklin St., Chicago. This belt has been handled in this country for some time but delays in transportation and the high cost of duty induced the establishment of a manufacturing plant here.

Balata is a vegetable gum of what is generally called the rubber family and cannot be vulcanized. Its discovery and original use dates back to the time of the Incas where it was discovered by Pizarro in use for gluing skins together in order to form shields. The gum comes from the Boela tree as a sap, and is obtained by bleeding or tapping; it may be cured by boiling it down as is done in the case of sugar sap, or by drying it in the sun in shallow trays.

As a foundation for the belting, cotton duck made of American long staple cotton and woven under high tension is used, and this is impregnated, not coated, with the Balata gum. The Balata has the peculiar property that friction is constant throughout the life of the belt and an overload which creates friction tends to soften the Balata and increase the adhesiveness. The Balata also furnishes a waterproof coating which is permanent. The tests show an average tensile strength of 9300 lb., so that the belt possesses the 2 main factors in usefulness, great adhesiveness, and high strength.

MONCRIEFF GAGE GLASSES

THESE glasses, which are made by Moncrieff in Scotland, are the product of 3 special conditions; first, the special skill acquired by over 40 yr. in manufacturing; second, a secret process of manufacture, and of mixing ingredients; third, the climate which is an aid in giving the proper temper to the glass.

As in the case of certain yarns which can best be manufactured elsewhere on account of the climate, so in the case of the Moncrieff gage glass, the climate of Scotland is helpful in producing the results, and even were Scotch sand and other ingredients, and skilled Scotch workmen employed in other localities, the makers state that the same results could not be attained there as are secured in the Scotch factory.

Two brands are made, the Unific for high pressure, up to 400 lb. steam pressure, and the Perth brand for lower pressures up to 200 lb. Each batch of glass is carefully tested as are the tubes. Examples are quoted by the makers of glasses which have been on boilers for over a year and are still in use, of those which have been in constant use for 14 months, and not yet broken, and of tubes on a locomotive used 98 days and covering 12,129 miles in weather ranging from January to May.

The glass is of a peculiar quality, so hard that a diamond makes but little impression on the outside surface, therefore, water will corrode it very slowly, if at all. The mixture is also one which gives a tough glass, not readily affected by heat and cold. It, therefore, remains clear for a long time and withstands even the hardest conditions. It is for sale in this country by H. A. Rogers Co., New York City.

NEWS NOTES

HARDY S. FERGUSON, for many years chief engineer of the Great Northern Paper Co., is now established as an independent consulting engineer at 200 Fifth avenue, New York City, and will particularly devote himself to engineering work in connection with paper, pulp and fiber mills.

MR. W. M. WHITE, formerly of the I. P. Morris Co., of Philadelphia, has become associated with Allis-Chalmers Co., as manager and chief engineer of its hydraulic turbine department.

During the past 10 yr. Mr. White has been closely in touch with hydraulic turbine development in this country and for the past 5 yr. has had entire charge of the designing for the I. P. Morris Co., in which position he has designed the hydraulic machinery for some of the largest installations in the country.

MR. FRED S. HICKEY, formerly with Anchor Packing Co., has associated himself with the Dearborn Drug & Chemical Works, as salesman for its feed water treatment and lubricants, in the loop district of Chicago.

HENRY R. COBLEIGH has resigned as mechanical editor of The Iron Age, which position he has held for the last 7 yrs., to take charge of the advertising and publicity of the International Steam Pump Co., 115 Broadway, New York City. He will enter upon his new duties May 1st.

DEANE STEAM PUMP CO., Holyoke, Mass., expects shortly to install a new power plant with equipment of about 450 kw. capacity and will take up the matter of oil, gas and steam plants as to their comparative merits.

ON FRIDAY, APRIL 28th, the Pittsburg Railway Club was entertained by the National Tube Co., at its works in Ellwood City, Pa. A special train leaving the P. & L. E. depot at 12:30 carried the members of the railway club, luncheon being served on the way to the plant. A most enjoyable trip was had, the manufacture of Shelby cold-drawn steel tubes, and Shelby hot rolled seamless steel tubes being thoroughly demonstrated. In the evening, F. N. Speller, metallurgical engineer for the National Tube Co., read a paper before the club on locomotive boiler tubes.

AT THE SPRING MEETING of the American Society of Mechanical Engineers to be held in Pittsburg, May 30 to June 2, Tuesday afternoon and evening will be devoted to the registration of guests and to the forming of acquaintances; Wednesday morning will be given up to the

mechanical engineering and cement manufacture meeting to be held in the Carnegie Institute, and Wednesday afternoon to a trip to the Universal Portland Cement Co.'s works, with a stop at East Pittsburg to visit the plants of the Westinghouse Electric Mfg. Co., and the Westinghouse Machine Co. At the morning session papers will be presented on Edison Roll Crushers, by W. H. Mason; Problems of the Cement Industry, by Walter S. Landis, and on Turbo Compressors and Forging Presses.

Wednesday evening will be given up to a professional session on Machine Shop Practice, at which papers will be presented by John Calder on Assembling Small Interchangeable Parts, on the same topic, by Halcolm Ellis, on the Design of Milling Cutters, by A. L. De Leeuw, and a Special Recording Indicator for Testing Machinery by Gardner C. Anthony. Thursday morning the professional session will be brief and will deal with miscellaneous topics in order to leave time for an excursion up the Monongahela River, including a visit to the National Tube Company's works at McKeesport. In the evening a reception and informal dance will take place at convention headquarters and Friday morning will be devoted to the concluding professional session on the subject of Steel Works Practice. The papers for this session will be on the Commercial Application of the Turbine Turbo-Compressor, by R. H. Rice, Hydraulic Forging Presses and Blowing Engines, Stresses in Tubes by Reid T. Stewart, Purchase of Coal on the Heat Unit Basis, by Dwight T. Randall.

Other papers to be presented will be on Energy and Pressure Drop in Compound Steam Engines, by F. E. Cardullo, Turbo Compressors and Pumping Engines, and Gas Engine papers to be presented at the special sessions of the Gas Power Section. Friday afternoon a trip to the Mesta Machine Co.'s works at Homestead, Pa., is planned, and the convention will close Friday evening with a smoker and entertainment given by the Engineers' Society of Western Pennsylvania, at its rooms.

MAX ROTTER, FORMERLY chief engineer of the Allis-Chalmers Co., of Milwaukee, has become affiliated with the Busch-Sulzer Bros. Diesel Engine Co., of St. Louis, Mo., in the same capacity.

AT THE MEETING of the National Gas & Gasoline Engine Trades Association, June 20-23, in Detroit, papers will be read as follows: By E. W. Roberts, on Aeronautic Motors; by P. E. Rose, on Farm Power; by J. B. Davidson, on What Colleges Are Doing and What They Should Do; by P. E. Edwards, on the Selling of Gas Engines.

PERCIVAL R. MOSES, 366 Fifth avenue, New York City, announces that he has associated with him the following engineers as permanent additions to his staff: John Fallon, recently with the Tennessee Copper Co.; Arthur V. Farr, formerly Szepssi & Farr; Alfonse Kaufman, formerly manager and chief engineer Alaska Chemical Co.; J. N. Walton, recently power engineer and storage battery expert, Brooklyn Edison Co.

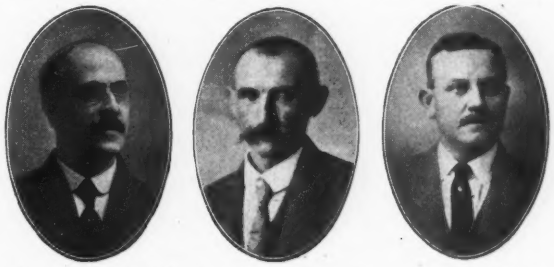
GENERAL OFFICES of the Under-Feed Stoker Co. of America have been removed to the 18th floor of the Harris Trust Building, on Monroe Street, between Clark and La Salle, Chicago, Ill.

HOMESTEAD VALVE MFG. CO., of Pittsburg, Pa., has appointed as agents in Louisville and vicinity E. D. Morton Co., which will carry a stock of Homestead Valves and will be ready to supply the trade in Louisville and surrounding territory at all times.

THE SPRAGUE ELECTRIC COMPANY announces the removal of its Boston office from the Weld building to 201 Devonshire street, Boston, where they have obtained larger offices in order to handle expeditiously the increased demand for the Sprague electric apparatus and Sprague conduit products in the New England territory.

FOR SOME MONTHS past the Geo. W. Lord Co. has been offering to give away to users of its compound 6 Trill Indicators complete, with reducing wheel, cord take up, 100 indicator cards, instruction book, etc., the whole packed in a neat mahogany case.

The first indicator was given to Curtis Warrington, whose picture we reproduce herewith. Mr. Warrington has been employed by Brewer Brothers, 614 Filbert



CURTIS WARRINGTON S. P. MORRIS G. C. WILHELM

street, Philadelphia, continuously since 1875, and during all that time has used Lord's Boiler Compound. He is a member of the American Society of Mechanical Engineers and several other engineering societies.

The Lord Co. did not agree to give out other prizes than the indicator but in looking over the returns they found that S. P. Morris, Hermosa Beach, California, had been using the compounds continuously since 1878 and G. C. Wilhelm, East Liverpool, Ohio, since 1879. This was too long a record to go without receiving some recognition, so the Lord Co. sent each of them a Waltham watch.

The second indicator will be awarded this month, in accordance with the coupon conditions as stated by the company.

CONNECTICUT STATE ASSOCIATION will hold its annual meeting at Hartford, Conn., June 23 and 24, in Putnam Phalanx Hall, corner of Pearl and Haynes St. The exhibit hall is of ample size and booths will be erected and decorated by the committee appointed by the Connecticut State Exhibitors' Ass'n. Headquarters of the convention will be at the Garde Hotel, corner of Asylum and High St.

The convention will be called to order by State President Charles H. Ostrander at noon of June 23, for the appointment of committees, and adjournment will then be taken until 8 o'clock in the evening. Delegates and guests will be welcomed by Hon. Edw. L. Smith, and an evening's entertainment will be tendered to the engineer's by the supply men. On Saturday the convention will meet at 9 o'clock to hear reports of committees, to elect officers and to transact other business which may come before the convention. At the conclusion of the business meeting, cars will be taken to a clam bake, baseball game and athletic meet, which every engineer is invited to attend and bring ladies with him.

ON THURSDAY EVENING, May 11, Branch No. 1, District No. 2, I. O. E., New York City, held its regular monthly meeting, at which F. L. Johnson, presented his paper on the Needs for Industrial Education. The paper drew forth considerable comment from the members and the discussion was both lively and interesting. About 50 members of the branch were present and the interest in the Institute seems to be growing constantly.

On Saturday evening, April 22, the seventh bimonthly meeting of Col. Goethal's Branch I. O. E., was held One new member was proposed and accepted and a committee appointed to interview other prospective members. A paper on the Theory and Operation of Hydraulic Laws was given by R. V. Madden, and a short paper on Water in Pipes was read by W. R. Vernon. Questions were discussed and subjects given out for next meeting.

AT THE MEETING of the T. J. Waters' Branch, No. 1, District No. 9, of Chicago, of the Institute of Operating Engineers, held on May 9, James P. Fleming, engineer of the Board of Education, was elected branch chairman; I. J. Bent, engineer of the Illinois Steel Co., lecturer on educational subjects, and W. L. Jackson, chief engineer of the First National Bank Building, lecturer on plant operation; O. Monnett, secretary-treasurer. Councilmen for 3 years were Willard Starr, P. J. Piper, Prof. A. W. Moseley; for 2 years, Clare F. Wilson, A. L. Rice, Prof. G. F. Gebhardt; for 1 year, Walter S. Cadwell, W. G. Lighty, and J. C. Miller.

At the close of the business meeting an interesting address was delivered on Recent Development in Steam Turbines, by F. E. Getts, steam turbine engineer for the General Electric Co. A large and interested audience listened to this lecture and also to the explanation of the objects of the Institute, which was given by one of the council members.

ON SATURDAY EVENING, June 17th, a special meeting will be called in the rooms of the Institute of Operating Engineers, 29 West 39th St., New York City, at 8 o'clock, at which the business of incorporating the Institute under the laws of the State of New York will be taken up. All of the members who can attend are requested to be present.

ALEXANDER E. BROWN, who was president of the Brown Hoisting Machinery Co. of Cleveland, Ohio, died on April 26. His company has long been a leader in the manufacture of hoisting apparatus and his departure is a great loss to the engineering profession.

JENKINS BROTHERS, after being located for 30 years at the familiar address, 71 John Street, transferred their headquarters on the 17th of April to 80 White Street, a much larger building, and giving increased facilities for carrying on the ever growing business of the company.

CATALOG NOTES

FOR THOSE WHO ARE HANDLING AIR COMPRESSORS of the direct-connected Westinghouse type, the Ideal patented packing for lubricating and protecting pump rods, as made by the Ideal Automatic Mfg. Co., of New York City, will be found of interest. An instructive booklet showing the method of operation of this packing is issued by the company and can be had on request.

BULLETIN 147A from the Bristol Co., gives a complete description of the Bristol Durand Radii Averaging instrument, and its application. Bulletin 146A on Bristol's Long Distance Recording Tachometers describes a new instrument now being put on the market to record the revolutions of shafting, machinery, and so forth. These bulletins may be obtained from the Bristol Co., Waterbury, Conn.

CENTRIFUGAL PUMPING MACHINERY as made by the Erie Pumping Works of Erie, Pa., is described in its booklet 26 just received.

BUFFALO SPRAY NOZZLES and Strainers, made by the Buffalo Forge Co., of Buffalo, N. Y., are used for giving a fine spray in gas washing, condenser systems, cooling towers, chemical plants and other similar places. The construction of the nozzle and strainer is shown in an interesting booklet sent out by the company.

THE ROAD ROLLER Zero Lubricator, made by the Detroit Lubricator Co., Detroit, Mich., embodies features not before used in the lubricator for a traction or road roller engine, which are described in an interesting pamphlet.

FROM THE RAW TO THE FINISHED PRODUCT is the title of an interesting booklet sent out by the Chicago Portland Cement Co., of Chicago, describing and illustrating the entire process of manufacture of Portland cement as well as showing the different uses to which cement is put in building construction.

THE DUNN OSCILLATING COKING STOKER, made by the Dunn Stoker and Water Gas Furnace Co., of Newark, N. J., is the subject of an interesting catalog, which gives, besides a description of the stoker itself, a discussion of automatic mechanical stokers, the combustion of fuel, the heat from burning different substances, and a comparison of stoking and hand firing. The stoker has a coking chamber as well as an inclined grate surface, and the sections have an oscillating motion by which the fuel is forced forward, first through the coking chamber, and afterwards through the furnace proper. Two interesting tables are included, one illustrating the process of combustion of different materials and showing the air or oxygen required per pound of combustible, the other showing the analysis of different fuels and the air required per pound of combustible fuel. The method of the action of the stoker is novel and interesting and includes, as explained in the catalog, the formation of water gas which burns in the furnace.

DEVELOPMENT AND APPLICATION of Central Station Heating is the title of an address delivered before the Pennsylvania Electric Association, by Charles R. Bishop of the American District Steam Co. It has been reprinted in bulletin No. 121 issued by the company from its office at North Tonawanda, N. Y., and explains the method of supplying steam for heating from a central station, the method of metering the steam, and gives results which have been obtained from central stations using this system.

Bulletin No. 122, issued by the same company, is entitled District Steam Heating Plants, and is a paper presented before the American Society of Municipal Improvements by Paul Mueller, manager of the Erie Co. It describes the method of installation of the steam mains, shows the advantage of the central heating system from the standpoint of the user, and gives the experience with the system in the city of Erie.

COMPLETE GAS POWER INSTALLATIONS for power and lighting plants, as installed by the Bogart Engineering Co., of Buffalo, N. Y., are described, and cost of operation of such plants is tabulated in an attractive little folder received from the company.

MESTA GAS ENGINE of the horizontal double acting 4-cycle type is described and illustrated in a beautiful catalog issued by the Mesta Machine Co., of Pittsburg, Pa. The views show a number of installations of engines and give a good idea of the details of construction as well as the general arrangement. An interesting comparison is made of cost of operation of gas plant and steam plant by means of chart showing where the heat goes to in the 2 kinds of plants.

NOISELESS VACUUM HEATING is discussed in a folder received from the Monash-Younker Co., of Chicago, which describes the Monash No. 6 4-way drain, shows how this may be used to produce noiseless vacuum heating without the damage to walls and ceilings that

usually comes from an air valve and also the folder shows a large number of fine buildings and plants that have been equipped with Monash radifier valves.

BURT MFG. CO., of Akron, Ohio, has just issued a most interesting catalog describing its oil filters, exhaust heads and ventilators. The oil filter is shown of several different styles and capacities to fit various conditions and there is also included the general system for lubricating plants with the Burt filters included as purifying outfit. Factory ventilation is treated at length and the simplicity with which this may be secured by means of the Burt ventilator is illustrated. The Burt exhaust head is shown as installed and also in section, illustrating the method of action in removing oil and water from exhaust steam.

BLAKE-KNOWLES Open Feed-Water Heaters are described in Bulletin B. K. 847. These heaters combine an oil separator, water filter, storage tank or hot well and heater, all made for the most part of cast iron and arranged with doors to give convenient access to the parts which need cleaning.

BULLETIN 1624 COVERS the standard line of Allis-Chalmers centrifugal pumps. It is well illustrated and instructive and shows numerous applications.

GENERAL ELECTRIC CO. recently issued bulletins describing its Type F Oil Switches. Bulletin 4821 deals with switches for use on circuits, the voltage of which does not exceed 15,000, and 4823 refers to switches designed for voltages of from 22,000 to 110,000. These switches are adapted to the requirements of modern stations employing these voltages. They are top connected and are, therefore, adapted to overhead station wiring. There is a double break for each pole and the break takes place in oil. These switches can be fitted with either hand operated or solenoid operated mechanism.

Bulletin 4806 illustrates and describes the company's electric fans for the coming season. The publication lists fans which use alternating or direct current and are suitable for home, office, and restaurant, and fans which can be placed on desk or table, or fastened to the wall or ceiling.

Bulletin 4820, supersedes its previous bulletin on curve drawing ammeters and voltmeters.

Bulletin 4799 illustrates and describes in considerable detail several types of revolving field alternators manufactured by this company. Both horizontal and vertical shaft alternators are illustrated.

"Charging the 'Electric' at Home" describes briefly the company's Mercury Arc Rectifier as used for charging the batteries for electric runabouts. The publication describes a method of overcoming the difficulties which usually attend the charging of the batteries.

A BOOK WHICH should prove very attractive to engineers has just been issued by the George M. Newhall Engineering Co. of Philadelphia, manufacturers of the Vance steam trap. The book is called the Engineers' Reference Book and more than half is composed of valuable information for the engineer, gleaned mostly from Kent's Mechanical Engineers' Pocket Book. There are between 50 and 100 subjects reprinted from Kent's alone, embracing information for which the engineer has almost daily need.

The book will be sent to anyone requesting a copy, and is partly devoted to a discussion and comparison of the different types of steam traps; a large portion of which is regarding steam trap capacities. A very original and practical method is given for determining what capacity of traps are required under all different conditions. The book also contains complete description of the Vance steam trap. Anyone desiring a copy of the book can obtain one without cost from George M. Newhall Engineering Co., by addressing them at 136 South 4th Street, Philadelphia.

THE PHENIX LUBRICATOR OIL PUMP, square and round types, is the title of an attractive 16-page catalog recently issued by the Richardson-Phenix Co. of Milwaukee. Besides pointing out the special applications and advantages of the Phenix Force Feed Lubricator for cylinder lubrication on main units and auxiliaries, the proposition of adequately lubricating auxiliaries is discussed at some length. Interesting data concerning different types of power plants show that the rubbing surface and also the power consumption of auxiliaries bears a rather high ratio to the total power output of the plant. The pamphlet then points out that it is foolish to spend a lot of money in proper lubrication of main units without devoting some attention to the auxiliaries. Copies of this pamphlet may be had by addressing the Richardson-Phenix Co., Milwaukee, Wis.

REASONS WHY Engineering Students go to the Worcester Polytechnic Institute is the title of an interesting and attractive booklet issued by that college which shows views in the different laboratories and class rooms, and also some of the outdoor and practical work which the students do. The equipment consists of full laboratory apparatus for instruction in steam engineering, gas engineering, automobile engineering, electrical engineering, hydraulic engineering, strength of materials, shop work, physics and chemistry, civil engineering and shop management. A copy of the pamphlet may be had by writing to Prof. Harold B. Smith, Worcester, Mass.

THREE SEGMENTS is the title of a story in 3 chapters, describing the Universal Flexible Packing, manufactured by the Universal Flexible Packing Co., of Pittsburg, Pa. This is of the cage form, made in 3 interlocking sections which fit inside a bushing and are backed by a fibrous cushion. Detailed construction of the packing is described in the booklet.

LEATHER BELTS, is the line at the head of an attractive cover page, showing the laced splice in a leather belt and describing the contents of the belting catalog of J. E. Rhoads & Sons, of Philadelphia. The book contains hints on the care and use of belting, rules for determining the proper power for a belt to transmit or the proper size of belt for a given power, a description of the methods of manufacture and cutting belting, forms of lacing for belt splicing, and of course tells the good points of the belts made by the Rhoads company. It explains also the advantage of cotton stitched and rubber belting.

CRANE STEAM AND OIL SEPARATORS as made by the Crane Co., of Chicago, are described in special circular 73, just issued.

STATISTICS in regard to Fort Wayne as a manufacturing center, and numerous illustrations of the present factories and buildings and municipal improvements are shown in a booklet entitled "Fort Wayne, Indiana's prettiest, happiest City," recently sent us by the Fort Wayne Electric Works. Among the views shown is a full page birds-eye view of the Fort Wayne Electric Works.

ADVANCE BULLETIN NO. 22 issued by the Elyria Gas Power Co., of Elyria, Ohio, on Efficient Gas Power, gives a mass of valuable and interesting information not generally known and never before published in regard to gas engine practice. It gives suggestions for determining the amount of power required in any plant, sizes of gas engines and the ap-

proximate horsepower ratings on natural gas, city gas, gasoline and producer gas, changes required when changing fuels, points in regard to admission, speed control, lubrication and cooling, methods of transmitting power from the engine, points to be watched when installing a gas engine, plant construction, details of an engine which should have attention in choosing methods of testing to determine the actual power to deliver, what should be included in a good engine equipment, and fuel cost for engines of different sizes at different rates per 1000 cu. ft. of gas. It is a valuable book for those considering the installation of power units as well as a guide for those in charge of the operation of gas engines.

BULLETIN 1031 on Squirrel Cage Polyphase Induction Motors is a catalogue recently issued by the Ideal Electric & Mfg. Co. of Mansfield, Ohio.

THE ENGINEER'S RED BOOK is a very attractive piece of literature gotten out by the American Injector Co., of Detroit, Mich. It illustrates and describes fully the complete line of injectors, ejectors, lubricators, oil cups and other steam specialties which this company manufactures, and contains in addition a number of important questions and answers relating to engine room practice. There is also a lot of general information on various other subjects which will be found quite useful. The company will be glad to mail one of these books, on request, without further obligation.

FROM THE BEST MFG. CO., of Pittsburg, has been received a folder of dimensions of valves, fittings, pipe bends, etc. This is especially valuable, not only because of the convenient form of the tables, but because it is fully indexed and is printed on heavy cloth so that it is durable and can be folded into convenient pocket form without tearing. The folder can be had by writing to the Best Mfg. Co., giving name, address, occupation and name of employer. This folder is No. 101. No. 102 is a price-list of flanged fittings and flanges. A notable feature of this list is that the same list price is given for both standard and extra heavy fittings and a different discount made for the 2 classes of goods. This method of figuring greatly simplifies the use of the price-list.

THE NELSON VALVE CO., of Philadelphia, is sending out correction sheets to be inserted in its 1909 catalog, showing changes in dimensions and prices on its various styles of globe and angle valves.

FROM ALLIS-CHALMERS CO. comes Bulletin 1042 describing a generating set made up of Allis-Chalmers generators and A. B. C. American Blower Co.'s engines. The bulletin gives full description of the details of the engine with cross section and separate views showing the crank construction, governor construction, valve motion and other interesting features.

TACHOMETERS, TACHOGRAPHS, Stroke and Revolution Counters as designed by Doctor Horn of Germany, and sold by the Industrial Instrument Co., of Foxboro, Mass., are described in its bulletin No. 40. It shows and describes the different styles of instruments and the records which they give.

THE AMERICAN-DIESEL ENGINE, as made by Adolphus Busch, who purchased the American-Diesel Engine Co., is described in general and in detail, and records made by this engine in actual running are given in an attractive 30 page catalog just received.

FROM THOS. H. DALLETT CO., of Philadelphia, come Bulletins 200, 201 and 202, giving the general construction and details of the company's air compressors and showing the arrangements of the parts for straight line belt-driven and straight line steam-driven machines.

EXPANSION JOINTS, anchor crosses, line anchors and other material for steam lines are illustrated and described in Catalog No. 7 by the Central Station Steam Co., Detroit, Mich. The same company in its Catalog 6 describes condensation meters, traps and screens for use in central station heating lines and in boiler feed lines.

TOLEDO TOOL NO. 25 for cutting threads on from 2½ to 6 in. pipe is described in an interesting folder sent out by the Toledo Pipe Threading Machine Co. The threading of these 7 sizes of pipe all with one set of dies is accomplished by shifting the dies by means of a taper-pin die receding principle. Two sets of dies are furnished with the tool so that one set can be kept always sharp and in reserve in case of emergency.

BULLETIN 1079 ON Steam Turbine Units contains a description of the Allis-Chalmers type of machine, together with numerous illustrations showing both details of construction and complete installations, representing practically every class of industry.

FROM CRANE CO. comes a new catalog of cast-steel valves and fittings for high pressure, steam, water and superheated steam. It has 64 pages, gotten up in the usual Crane style of excellence. It is known as Special Steel Catalog No. 70.

TRADE NOTES

THE ROCHESTER LEAD WORKS, Rochester, N. Y., has recently installed a 100 hp. Syracuse producer, which is giving excellent satisfaction. This replaced a smaller outfit made by another manufacturer. J. J. Bartholomew & Son of Vernon, N. Y., is having installed a 50-hp. Syracuse producer to use as an auxiliary to its water power. The Cycle Hatcher Co., Elmira, N. Y., has recently installed a 50-hp. producer of this make.

FRANCE PACKING CO., of Tacony, Philadelphia, has a most successful metal packing for gas engines which embodies the good points of the France steam packing and also has provision for housing the spring so that dirt, grit or flame cannot come in contact with the spring. This gas engine packing has been used for 5 years in the most severe service, giving entire satisfaction, and is sold on the condition that it will give satisfaction or payment need not be made.

FACTS WHICH LEAD to statements such as the following, received by Charles A. Schieren & Co., 30 Ferry St., New York, are well worth consideration of engineers who have belt trouble: "After having made a thorough test of your 'Duxbak Steamproof' belting on our 120-in. planer, I am pleased to speak of it in the highest terms for its great pulley capacity. I have placed 9 steel pistons weighing on an average of 80,000 pounds, taking as much as 1¼ in. at a cut. Castings 10 ft. by 16 ft. in size. After putting your belting on the planer, our trouble was over in the slipping and breaking of belts, and I take pleasure in recommending it as the best belting I have ever tried." Camden Iron Works, by Walter F. Wolfkeil, Sup't of Machinery.

IT IS INTERESTING to learn of some of the far away places where the Parker Boiler Co. of Philadelphia has recently installed a few of its downflow boilers. It is also convincing proof of the satisfaction these boilers give to note that 2 out of these 4 orders

are repeat orders, the second received from these concerns. The list is as follows: United Verde Copper Co., Jerome, Ariz., one 372-hp. boiler, second order; Hawaiian Pineapple Products Co., Honolulu, one 122-hp. boiler, second order; California Oil fields, Coalinga, Cal., 2 137-hp. boilers; Pueblo County Court House, Pueblo, Colo., 2 207-hp. boilers.

ON THE 22ND OF MARCH the Foos Gas Engine Co. shipped to the United States government 2 engines for use on river improvement work at one of the dams near Wheeling, W. Va. These were designed along the line of heavy duty multiple cylinder type having 3 cylinders, each of 100 hp. capacity.

THE FOLLOWING IS A STATEMENT made by Mr. Hartman, Proprietor of the Model Laundry of St. Louis, Mo., where Jones stokers have been recently installed: "I have a smokeless stack, my coal bills are materially reduced; but to what extent I cannot at the present time state. But the most notable feature and one which I do fully appreciate is, the time my engineer now has for carefully noticing the operation and condition of all the machinery throughout the plant, and keeping it in repair. This I think will more than repay me for the expense necessary for making installation, within a period of eighteen months. It is the only device for a small plant, one man operating. Steady steam and a good fire."

THE U. S. NAVAL Experimental Station at Annapolis has requested the George M. Newhall Engineering Co. of Philadelphia, Pa., to furnish their high and low-pressure Vance steam traps for a series of tests.

TRIUMPH ELECTRIC CO., of Cincinnati, Ohio, reports that during the past year it has developed new lines of lighting transformers and alternating current generators. As an evidence of the company's growth, a new branch office has been opened at New Orleans, La., which is the 16th branch office, 3 of them established during the past year. The company has been in the present factory 21 months and its growth in business, increased orders and improvements in apparatus are most encouraging to the management. L. H. Thullen, who has been consulting engineer and designer in New York City, is now the chief engineer for the Triumph Electric Co.

JOHN H. M'GOWAN CO., of Cincinnati, Ohio, is installing pumping machinery for the city of Chillicothe, Ohio, consisting of a horizontal compound engine steam pump for delivering 3,000,000 gal. of water per day; and at Madison, Ind., a triple-expansion machine of the vertical condensing type is being installed, which will have a capacity of 5,000,000 gal. per day. The equipment for a plant at Lakeland, Fla., has also been sold by this company, the capacity being 1,500,000 gal. per day.

YORK MANUFACTURING CO., reports the following among its recent sales: Hotel Baltimore, Los Angeles, Cal., 1 4-ton refrigerating machine; Standard Waygood, Ltd., Sydney, New South Wales, 1 2-ton and 1 6-ton high pressure sides; P. C. Schuller, Johnstown, Pa., 1 15-ton ice making plant and refrigerating system for ice cream plant; The Kent Co., Ltd., Montreal, Canada, 1 5-ton refrigerating plant for Royal Victoria Hospital, Montreal, Canada; Dickinson & Fenneman, Devine, Texas, 1 5-ton ice making plant; Cushing Ice Co., Cushing, Okla., 1 20-ton refrigerating machine; Virginia Brewing Co., Virginia, Minn., 1 45-ton refrigerating machine and high pressure side; Fergus Brewing Co., Fergus Falls, Minn., 1 20-ton high pressure side, direct expansion piping, and equipment for brewery; Berlin Brewing Co., Berlin, Wis., 1 35-ton compression side, and 6000 ft. of 2-in. direct expansion piping; Chicago Brewing & Malting Co., Chicago, Ill., 1 300-ton horizontal duplex cross-compound refrigerating machine; Allen Candy Co.

MURRAY IRON WORKS CO. of Burlington, Iowa, is just completing an extensive addition to its boiler shops in the shape of a steel frame building 140 by120 ft. with a large traveling crane down the middle and smaller cranes on the sides. This will enable these works to produce more water-tube, tubular and fire-box boilers in the future than they have been able to do in the past.

THE AMERICAN SHIP WINDLASS CO., manufacturer of the Taylor stoker, has just received an order from the Milwaukee Electric Railway and Light Co. for 4 stokers to be applied to 4 300-hp. Edge Moor boilers in the Commerce street plant. For a considerable period this company, before placing this order, carried on an exhaustive series of experiments with stokers.

SALE OF THE Bundy Steam Trap has been discontinued by the American Radiator Co., and taken over by the Nashua Machine Co., of Nashua, N. H. The selling department for the Bundy Trap will be located at 127 Federal St., Boston, Mass., and will be in charge of John Sabin, sales manager, who has been closely associated with the Bundy Trap for a long time.

DEALERS WHO HANDLE the Kewanee Union will be interested in the Kewanee Union Pennant sent out by the National Tube Co., to call attention to this union. It is an attractive device and one sure to attract the attention of visitors to a store.

THE VILTER MFG. CO., with offices at Milwaukee, Wis., report the following list of recent sales: Green Bay Water Co., Green Bay, Wis., 14 by 24 in. Corliss engine; Salem Brewery Association, Salem, Oregon, 32-ton refrigerating machine and 12 by 30 in. Corliss engine; Chas. F. Netzow Mfg. Co., piano manufacturers, Milwaukee, Wis., 15 by 30 in. direct-connected Corliss engine; Statter & Co., meat packers, Sioux City, Iowa, 16-ton double pipe ammonia condenser; Joliet Citizens' Brewing Co., Joliet, Ill., 50-ton refrigerating machine and 10 by 36 in. heavy duty Corliss engine; Milwaukee Hospital for the Insane, Milwaukee, Wis., 16 by 30-in. direct-connected Corliss engine; The Fairmont Creamery Co., Omaha, Neb., 15,400 ft. 2-in. galv. exp. piping; Richmond Cold Storage Co., Eugene Robinson, Prop., Richmond, Va., 85-ton refrigerating plant and 65-ton refrigerating plant, 18 by 36 in. heavy duty Corliss engine and 18 by 42 in. heavy duty Corliss engine; Forest City Brewing Co., Cleveland, Ohio, 80-ton refrigerating machine and 18 by 42 in. Corliss engine; Bohle Ice Cream & Baking Co., Philadelphia, Pa., 16-ton refrigerating machine; Harry Ogle, ice cream manufacturer, Wildwood, N. J., 7-ton refrigerating machine.

THE BOSTON & MAINE R. R. Co. is making a test with a high-pressure Vance steam trap to work under superheat. This trap is equipped with Monel metal valves and seat, and the outcome is being watched with interest by the engineering profession. The Vance steam trap is made by the George M. Newhall Engineering Co., with offices at 136 South 4th St., Philadelphia, Pa.

CROCKER-WHEELER CO., of Ampere, N. J., is now prepared to furnish 3-wire direct-current generators for practically any capacity. With this type of machine the neutral is obtained from an additional generator winding in the armature which is connected to a single connecting ring and no transformers are used. The ring is placed on the front end of the commutator spider and its brush holders are carried from the main brush brackets.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 20th of month preceding publication.

Positions Wanted

POSITION WANTED—First of June, by engineer and electrician. Moral habits and industrious. Place in the west preferred. References. Address Box 173, Practical Engineer, Chicago, Ill. 5-1

POSITION WANTED—By electrician, 27 years of age, to take charge of electric light and power station. Seven years' practical experience. Married. Strictly sober. Address Box 174, Practical Engineer, Chicago, Ill. 6-1

POSITION WANTED—As electrician or assistant engineer in manufacturing or hotel plant. American young man, 30, honest, reliable, sober, wants offer. First-class references. 12 years' experience central stations and isolated plants, A. C. and D. C. apparatus, steam engines and turbines, interior wiring and construction. Give full particulars and address Box 171, Practical Engineer, Chicago. 5-2

POSITION WANTED—By young man as assistant or oiler in engine room. Have completed steam engineering course in I. C. S. Age 20. Moral habits and industrious, some experience. Give full particulars. Address Clement E. Benham, Box 181, Soldier, Blaine Co., Idaho. 5-2

POSITION WANTED—Young man experienced in construction and maintenance, hoisting, conveying and handling machinery desires permanent connection or erecting work. Good labor handler. Sober. References. Address Box 169, Practical Engineer, Chicago, Ill. 5-2

POSITION WANTED—As oiler or assistant engineer by young married man 21 years of age, around a steam power plant. Have I. C. S. education and twelve months' experience. Please state full details in first letter. Address Box 170, Practical Engineer, Chicago, Ill. 5-2

POSITION WANTED—As engineer in power or manufacturing plant; experienced with all kinds of engines and boilers; references. Address Box 165, Practical Engineer, Chicago, Ill. 5-2

POSITION WANTED—Young man 25 years of age would like position as engineer in small plant; have had experience in ice plant and also have run steam roller; good habits. Address M. Hughson, Shelby, Mich. 5-2

POSITION WANTED—Young man 23 years of age would like position as engineer. Four years' experience with steam plant. Can come at once. Address Charles Ferris, 23 N. Grove St., Grand Rapids, Mich. 5-2

POSITION WANTED—As fireman or assistant engineer in small stationary plant or somewhere around machinery; 3 years' experience on a dredge boat; good habits. Address Box 163, Practical Engineer, Chicago, Ill. 5-2

Help Wanted

BE AN AGENT FOR Practical Engineer in your city. Pleasant part or whole time work calling on your engineer friends. Liberal cash commission on every subscription taken. Write to Subscription Dept. for information. 6-1

LOCAL SALESMAN WITH established trade in packing, oils or grease can obtain good side line with no samples. Address Manufacturer, Box 172, Practical Engineer, Chicago, Ill. 6-1

AGENTS WANTED—TO SELL lubricating oils, belts, hose, paint, varnish, to factories, mills, stores, threshers; exclusive territory to right party; experience unnecessary. Manufacturers Oil and Grease Co., Cleveland, Ohio. 4-3

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

COMPETENT AND EXPERIENCED stoker erectors at once. State age, experience, reference and salary expected. Give full details. Address Box 168, Practical Engineer, Chicago, Ill. tf

WANTED—A SALESMAN FOR the Chicago and surrounding territory to handle our line of power plant specialties on liberal commission basis. Address Box 164, Practical Engineer, Chicago, Ill.

Wanted

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. 6-1

WANTED—5,000 STATIONARY ENGINEERS to send us their name and address. A good proposition open to each one. For full particulars, write Henry W. Lord, 7 S. Greene St., Baltimore, Md. tf

For Sale

FOR SALE—ENGINE INDICATOR, outside spring two cylinders and pistons, ¼-in. and ½-in. areas, reducing wheel, only been used 6 months. Good as new. Have no use for it and will sell cheap. Address Box 175, Practical Engineer, Chicago, Ill. 6-1

Patents and Patent Attorneys

PATENTS—WANTED, IDEAS—Manufacturers are writing for patents procured by me. Send for free 72-page guide book and list 200 inventions wanted. R. B. Owen, Dept. 28, Washington, D. C. tf

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. 10-tf

PATENTS—C. L. Parker. late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the inventors. Handbook for investors sent upon request. 186 McGill building, Washington, D. C. 4-tf

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FREE TUITION BY MAIL—Civil Service, Mechanical Drawing, Stationary Engineering, Electric Wiring, Agriculture. Poultry, Normal, Book-keeping, Shorthand and Typewriting Courses. For Free Tuition, apply Carnegie College, Rogers, Ohio. 6-1

Miscellaneous

MAKE MONEY on the side. Here's your chance to pick out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. 6-1

SUBSCRIBE NOW for the 1911 issue of the Stationary Engineers' Directory of the city of Philadelphia; $5 per copy. Mail checks to Stationary Engineers' Club, 1108 Arch street, Philadelphia, Pa. 5-2

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1413 W. Jackson Blvd., Chicago, Ill.